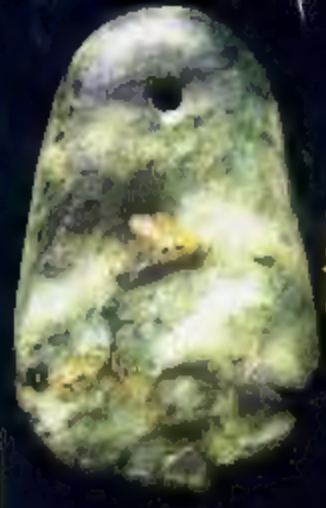
AUGUST 2007

Rock&Gem

THE EARTH'S TREASURES • MINERALS AND JEWELRY



NATURE'S LAPIDARY TOOLS

THE MIRACLE MINERAL

Sulfur's Split Personality

SOONER STATE SELENITES

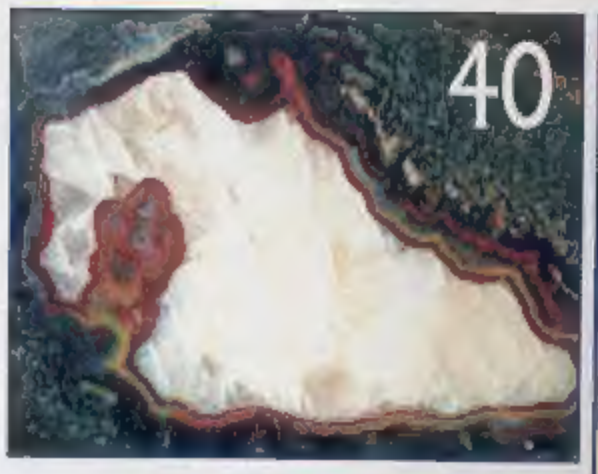
AMAZING AGATES FROM MOROCCO

GEM ADVENTURES IN THAILAND

0 74808 02033 1

Rock&Gem

Volume 37, Number 8 August 2007



FEATURES

Sulfur 12
It's an important nonmetal element
by Bob Jones

Adventures in Specimen Buying 20
Collecting minerals in Thailand's gem markets
by David Bright

Roadside Panning Sites in South Carolina 34
Part VI: Spartanburg, Union and York counties
by David and Clois Walker

Supersaurus viviane 40
A tribute to rockhound pioneer Vivian Jones
by Barbara L. Miller

Rock & Gem Kids 48
Hexagonal crystals, part 2, dioptase, and a quiz
by Steve Decker

The Natural Lapidary 50
Sculpting soft stone using Stone-Age techniques
by Storm

The Franklin and Sterling Hill Zinc Mines 60
They're famous for fluorescents
by Bob Jones

Getting Out, Getting Dirty 72
The MAGMA club story
by Richard Jacquot

Berber Country Agates 88
Morocco has an incredible variety
by Bob Farrar

FIELD TRIPS

Great Salt Plains Selenite 28
Collecting in Alfalfa County, Oklahoma
by Kenneth H. Rohn

Phoenixville Dolomite Crystals 80
A unique collecting site near Philadelphia
by Robert Beard

REGULAR COLUMNS

Craftsman of the Month 6
Show Dates 8
Shop Talk 18
Off the Dop 26
Picks & Pans 68
Rock Science 76
Subscriber Service Information 78
How to Subscribe 79
Many Facets 86
On the Rocks 96

ON THE COVER The volcanic environment of Sicily has long produced attractive sulfur crystals on matrix like this 8.3-centimeter-high specimen. (Jeff Scovil photo/Irv Brown specimen)

Miller Magazines, Inc.

Rock & Gem (ISSN 0048-0453, USPS 486-290) is published monthly by Miller Magazines, Inc., 290 Maple Ct., Ste. 232, Ventura, California 93003-3517, telephone (805) 644-3824. Periodicals postage paid at Ventura, CA 93006, and additional mailing offices. Single-copy price $4.99. Subscription in U.S.A. and possessions: 1 year (12 issues) for $24.00; 2 years for $42.00; 3 years for $54.00. Add $15.00 per year postage for Canada and all other foreign countries. Submission of articles and photos by our readers is welcome, but we can accept no responsibility for loss or damage to unsolicited editorial contributions.

Copyright 2007 by Miller Magazines, Inc.

Printed in U.S.A.

Notice: On rare occasions, typographical errors occur in prices listed in magazine advertisements. For this reason, advertisements appearing in *Rock & Gem* should be considered as requests to inquire, rather than as unconditional offers to sell. All prices are subject to change without notice.

POSTMASTER: Send address changes to *Rock & Gem*, P.O. Box 469113, Escondido, CA 92046-9113 or RockAndGem@pcspublink.com

SUBSCRIPTION QUESTIONS? Call (760) 291-1549

BOB JONES Senior Consulting Editor; **LYNN VARON** Managing Editor; **MARY ROBERTSON** Art Director; **JOE HOWARD, DANIEL COHAN** Graphic Designers; **DANA GURNEE** Production Assistant; **ROBERT BEARD, STEVE DECKER, WILLIAM A. KAPPELE, JIM PERKINS, DIANE PROKOP, KENNETH H. ROHN, STEVE VOYNICK** Contributing Editors; **BRIAN ROBERTS** Advertising Director; **SOOK GUMPEL** Classified Advertising Manager; **CELESTE WEINGARDT** Advertising Production Manager; **DRAY BANKS** Advertising Production; **JEFF SHOOP** Publisher

EDITORIAL SUBMISSIONS:
Lynn Varon / *Rock & Gem*
290 Maple Ct., Suite 232, Ventura, CA 93003
(805) 644-3824 ext. 29
e-mail: editor@rockngem.com

ADVERTISING INQUIRIES:
Brian Roberts / *Rock & Gem*
11288 S. Indian Wells Dr., Goodyear, AZ 85338
(623) 327-3525 phone/fax
e-mail: brian@millermags.com

Sulfur

Long known for its volcanic emanations, Sicily has yielded magnificent sulfur crystal specimens.

An Important Nonmetal Element

Story and Photos by Bob Jones

Oxygen is the most important of all the natural elements. True, gold is valuable, but you would never live to spend gold if you did not have oxygen to breathe! Oxygen also plays a role in a great number of mineral compounds. There is no argument that oxygen, of all the elements, is the most important.

Oxygen is a nonmetal element, meaning it is more likely to accept electrons into its structure in a chemical reaction; metals tend to give electrons from their structures. Next to oxygen, sulfur and carbon rank as the other more important nonmetal elements. They also take in electrons in chemical reactions. Life is based on the carbon atom, as it is the cornerstone of almost all organic compounds—your organs, for example!

While sulfur plays a significant role in the development of life, it is most important in the formation of metallic compounds in nature. We mine these sulfur compounds, which we call sulfides and sulfosalts, for their useful metals. When such sulfur compounds weather, they form sulfates, minerals that combine sulfur with oxygen.

The giving and taking of elements is critical in the formation of all chemical compounds, including mineral compounds, most of which are simple to complex combinations of metal and nonmetal elements. Some minerals we enjoy are exceptions, such as the native elements gold, silver, sulfur and carbon (diamond and graphite), which form their own inorganic crystals without the aid of other elements. Still, electrons are active participants in the final crystal form these native elements take as they join with atoms of their own kind.

Sulfur is one of the prettiest of the natural elements. It is certainly far showier than a natural uncut diamond and it rivals gold for fine color. Alchemists, in their search for a way to change base metals to gold, always added sulfur to their experiments in hopes its yellow color would transfer to the anticipated gold product.

Sulfur, in its various compound forms, is also one of the most important elements in the industrial world. Sulfuric acid, for example, has myriad uses in manufacturing and metal recovery and is the most used acid in the manufacturing industry.

Nature would be hard pressed to replace sulfur as one of the most important conveyors of metals from the earth's interior. It depends on sulfur to combine with lead, zinc, iron, copper, and a host of other metals to form sulfides or sulfosalts, which are brought near the earth's surface by hydrothermal action. These, in turn, break down and form sulfates.

By itself, sulfur is benign, but combine it with the important nonmetals oxygen or hydrogen, and the results are

The quarry at Maybee, Michigan, produces fine, bright-yellow sulfur on pale blue celestite.

The San Felipe deposit on the Baja California peninsula of Mexico is well known for its delicate clusters of stalactitic sulfur crystals.

at the very least smelly and at the very worst deadly. With oxygen, sulfur can form the simple gas sulfur dioxide, a gas with an unpleasant odor like the one you smell when striking a match. Enough of it can make you ill.

Join sulfur with three atoms of oxygen, and the resulting gas is exceedingly corrosive. When sulfur and hydrogen form a gas compound, the result goes beyond nauseating to downright poisonous. A small amount of this gas we call hydrogen sulfide smells like rotten eggs. In quantity, it will kill you!

The smell that issues from a rotten egg is due to the action of bacteria like Beggiatoa alba or Chromatium akeina. They attack the egg yolk, causing it to rot and produce stinky hydrogen sulfide.

The fact that sulfur is used in match heads tells you it is a flammable element. It will not burst into flame by itself; phosphorus in the match initiates the burning. Sulfur burns with a delicate blue flame as it combines with atmospheric oxygen to form sulfur dioxide.

In a very real sense, sulfur can have a Jekyll-and-Hyde personality, the Mr. Hyde side forming compounds that are poisonous, and the Dr. Jekyll side forming some of the more important and useful compounds on and in the earth.

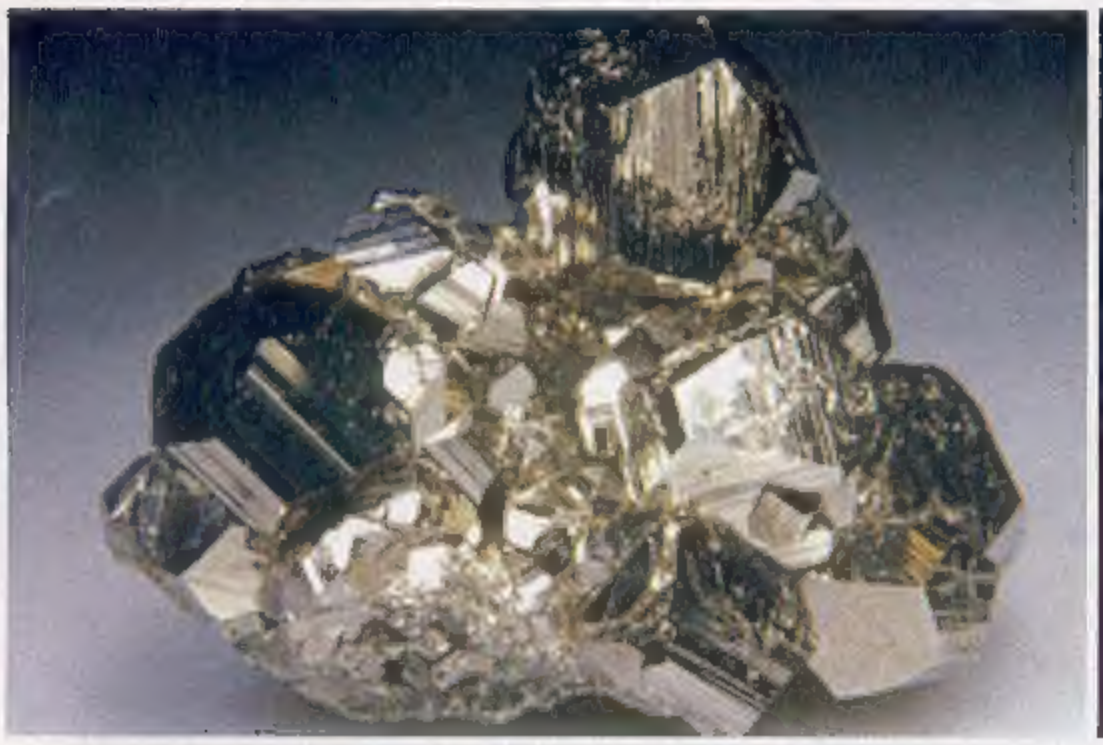
Sulfur's role in creating minerals is obvious in the names of three very important mineral groups: sulfides, sulfosalts and sulfates. Sulfides are the primary mineral compounds of the earth. They constitute the vast majority of the ore from which we extract metals. Though not as common as the sulfides, the sulfosalts also constitute an exceedingly important group of metal compounds, in particular those that yield silver.

Note here the endings on words like sulfide and sulfate. In chemistry, the suffix "-ide" denotes a mineral that lacks oxygen and often contains sulfur. The ending "-ate" means it contains oxygen. Mineral names ending in "-ite" contains neither sulfur nor oxygen, such as halite (sodium fluoride).

On its own, sulfur forms beautiful yellow crystals of dipyramidal habit. Perfect dipyramidal crystals look like two truncated pyramids attached base to base. Sulfur can also form tabular crystals or stalactites. It sometimes develops twins and is even found in spherical crystals that are quite attractive. Sulfur is lustrous; its luster ranges from greasy to vitreous. Crystals are usually transparent or nearly so, but can be clouded with impurities. Sulfur crystals can exceed an inch, but tightly interconnected clusters of crystals are frequently found in masses up to several feet across.

Sulfur crystals form under different circumstances. As a primary mineral issuing from the earth, it often forms as small crystals in the throat of a volcano as it emits huge quantities of sulfur gases, most commonly sulfur dioxide. Volcanoes spew out maybe twice as much sulfur, in the form of sulfur dioxide, into the atmosphere as all industrial emissions combined. This is powerful evidence of the amount of sulfur lurking within the bowels of the earth.

continued on next page



Sulfur is one of the major components of sulfides like this Peruvian pyrite, an iron sulfide mineral.

This specimen of sulfur shows the classic perfect crystal form and fine gemmy color of the native element.

When hot sulfur fumes are emitted by a volcano, they sublimate as soon as they hit the cool atmosphere. In sublimation, instant cooling causes the gas to form solid crystals without going through a liquid stage. It simply turns from a smelly, sometimes poisonous gas to an odorless solid. This is the reverse of what solid dry ice does when it goes directly from a solid to the gaseous state, which is why we call it "dry" ice. There is no liquid phase evident.

Sulfur crystals form on the inner walls of volcano vents and craters, sometimes in quantity. This fact did not escape Cortez's notice when he was pillaging Mexico. Needing more and more gunpowder, Cortez and his men put slaves to work scraping the walls of active vents and volcanoes for sulfur, including the famous Popocatepetl near Mexico City. This was dangerous mining for the slaves; the fumes they breathed would at the very least make them sick and would sometimes kill them.

While venting volcanoes were the first important natural source of sulfur, major production of sulfur began when native sulfur was found in deposits of marl and limestone derived from ocean water. Marls are largely composed of calcium carbonate originating from organisms that once lived in the ocean.

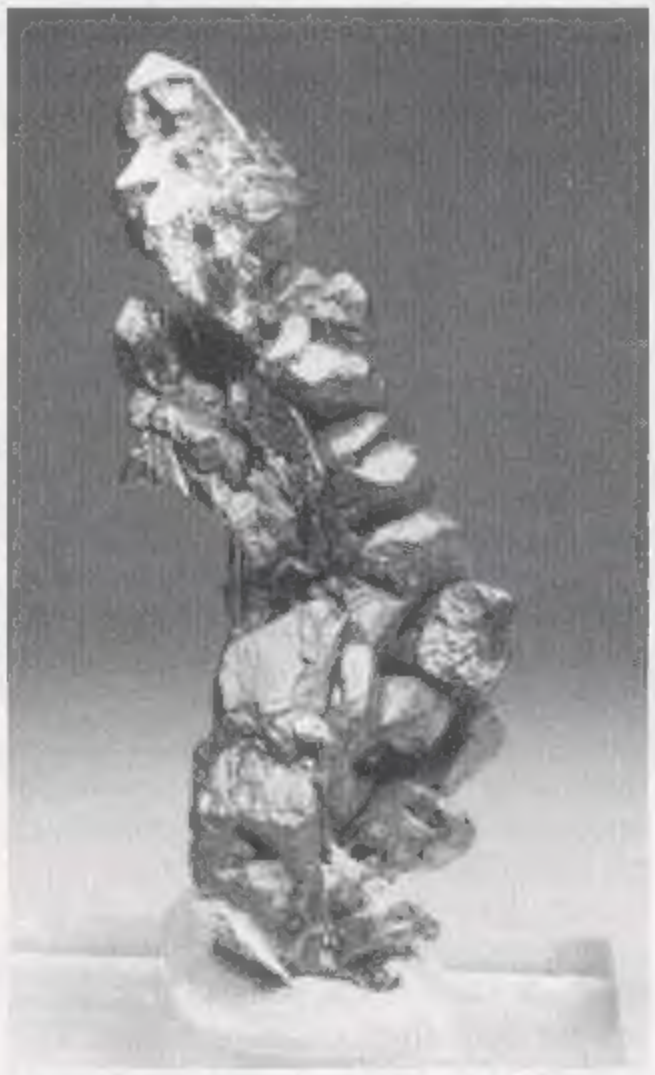
In limestone and marl, the action of bacteria is highlighted. Certain bacteria attack sulfur compounds that are found naturally in ocean water. The bacteria release elemental sulfur, which ends up being deposited as crystals in and on the rocks that are forming. The most important and more famous sources of this sulfur are the salt domes of Texas and Louisiana. These underground deposits are massive domes of marl rock and salt water loaded with sulfur. Unfortunately, the mining of this yellow mineral destroys whatever crystals may have formed originally.

For collectors, a much more accessible source of sulfur in marl and limestone is the region around Maybee and Scofield, Michigan. During rock quarrying, fine sulfur crystals, often associated with celestite, are encountered and sometimes saved. Even more important to collectors are the marls and limestones of Italy and Sicily. These ancient deposits have produced the most attractive specimens of sulfur on earth in unrivaled quantity.

While sulfur that forms naturally is usually a bright yellow, it can also be yellow-orange to orange if it contains small amounts of selenium. You might hear it called by the misnomer selenosulfur.

Sulfur is a relatively soft mineral and is brittle. It has a conchoidal fracture, and if held tightly in the hand, it will crack internally from heat expansion. Sulfur specimens, however, can be handled without fear of cracking.

Sulfur's low melting point, 113 degrees Celsius, is most important in the mining of sulfur from the salt domes of the southern United States. These deposits produce the greatest amount of sulfur used in industry. Molten sulfur is pumped from underground, forming large lakes. It is allowed to cool, then piled in heaps until it is ready for shipment or conversion to a useful compound. Sulfur from salt domes is produced by the Frasch process, a method developed by a German chemist.



Most silver is mined from sulfosalt compounds, which consist of silver and another metal combined with sulfur.

The process is simple: The salt dome is core drilled. Sometimes, the cores actually have small vugs with sulfur crystals in them. Once drilled, super-hot (163 degrees Celsius) steam is pumped down the drill hole to melt the sulfur. Compressed air then drives the liquid sulfur to the surface. Due to the heat, it comes out a lovely orange, but quickly returns its natural yellow.

I was once judging a show in which one competitive mineral exhibit contained two drill cores with vugs of small sulfur crystals. The exhibitor was very irate when I subtracted points because of the drill cores.

Sulfur has an odd internal molecular structure. Normally, the atoms of sulfur link in a complete circle or ring. In that form, the sulfur has certain properties: it is bright yellow, it flows easily when molten, and it is a very useful element. When solid sulfur is heated enough, however, the ring structure of the atoms breaks up and they form nearly endless chains that continually tangle and twist. This causes several things to happen. First, the color of the sulfur grades into orange, and with continued heating it would actually turn black! Second, its ability to flow slows as the rings break and the long chains of atoms evolve. It eventually gets so sticky it will hardly flow at all, just like cold molasses. When the sulfur cools, the ring structures slowly reform and the sulfur is soon a pleasant yellow again.

Sources of well crystallized sulfur for collectors are numerous, though none are as prolific as the Sicilian deposits. The quarries at Maybee and Scofield, Michigan, have produced some of the nicest sulfur crystals found in the United States. As in so many marl/limestone deposits, the sulfur is associated with celestite and gypsum. The crystals are pale yellow and seldom reach an inch, but are quite showy. They form on and with the other minerals, making quite nice specimens.

Single, loose Sicilian crystals are common because the crystals are easily broken away from the matrix, often during mining. Nice matrix specimens, therefore, are not readily available.

Mexico has one major source of native sulfur crystals. Frequently visited by rockhounds for many years, the San Filipe, Baja California, deposit was finally worked for specimens by a company from Tucson, Arizona. It recovered a good supply of these interesting sulfurs. This sulfur is a very attractive, brilliant yellow with a vitreous luster. The crystals are never large; ½ inch is about as big as they get. What makes the San Filipe sulfur interesting, and almost unique, is the stalactitic form it takes.

It develops in flat plates of crystal stacks that are quite brittle. A nice specimen consists of slender stems, or stalactites, of crystals that build vertically in tightly clustered and usually terminated, fingerlike crystal groups. Each of these slender "fingers" is actually a stack of small crystals topped by a fairly large crystal. These odd, slender growths can be an inch or two long and stand in subparallel groupings. Plates of them are usually no more than a few inches across. Careful mining will bring out larger plates.

continued on page 16

Scattered within these clusters of sulfur crystals are spongy-looking crystalline sheets of selenite. Some of the sulfur "fingers" actually extend above and below the gypsum as if they penetrated right through the gauzy hydrous calcium sulfate. The selenite looks as though it has been partly dissolved or perforated. The transparent white selenite contrasts nicely with the bright-yellow sulfur. Production at San Filipe has been sporadic for years, as continued mining depends on the success of the diggers.

Steamboat Springs, Nevada, is named after the hot springs in the area. Small clusters of intergrown sulfur crystals have developed associated with these springs and have been collected for the element and for their specimen value.

The general public is well acquainted with sulfur and its noxious fumes. Its distinctive smell is particularly associated with one of this country's great natural wonders, Yellowstone National Park in Wyoming. This remarkable region is underlain by a huge volcanic magma mass—actually a plume—over which the continent has shifted through the eons. You can actually trace the path of the shift by the spots in which this volcanic plume has reached the surface in past millennia. Craters of the Moon National Monument, which is not all that far from Yellowstone, was created by this same volcanic plume in the distant past, but is now dormant due to a crustal shift. Scientists predict that, as the continental crust continues its slow shift, portions of the vent and geyser system in Yellowstone Park will slowly tail off in activity, while new areas will develop.

Close inspection of the vents from which hot springs and geysers burst forth reveals native sulfur as either tiny crystals or bright-yellow coatings. This sulfur has sublimated from the gases coming up the hot spring or geyser vent. When the sulfurous gases hit the cold air, sublimation is instantly triggered and sulfur forms. The crystals are scarcely, if at all, visible, but are still evidence of the sulfurous nature of the volcanic action of the area.

One of the most scenic areas in Yellowstone Park is the Grand Canyon, a colorful gorge some 300 feet deep-down which the Yellowstone River tumbles. The walls of this canyon are rich in mineral salts, primarily iron compounds with minor amounts of sulfur. More sulfur is evident around the fumaroles and the caldrons. Caldrons are short of water, so they do not flow or erupt, but are rich in sulfur and smelly sulfur gases. The waters of the aptly named Sulphur Caldron are yellow due to the native element (this earlier spelling of sulfur is now disused in mineralogy).

Carlsbad Caverns in New Mexico also deserves attention in an article about sulfur because of the odd way it developed into such a huge cavern. Carlsbad may be unique in our national park system. Most caves form when rain falls through a carbon dioxide-rich atmosphere, becomes acidic, and etches away limestone to create openings. The limestone, which is an impure form of calcium carbonate, remains in the rainwater and, under the right conditions, this calcium carbonate is deposited on and in the created openings forming stalactites, stalagmites, and other cave formations.

Tight clusters of intergrown Sicilian sulfur crystals can be seen in most of the world's museums.

Carlsbad Caverns initially formed like any other limestone cavern. When scientists began to really study Carlsbad, however, they concluded that something else had caused massive enlargement of the cavern openings, which could not be accounted for by flowing water. At Carlsbad, no evidence of large volumes of water flowing into or out of the cavern has ever been found. Enter the theory involving sulfur and bacteria.

Carlsbad began forming millions of years ago when the part in New Mexico in which it is located was under warm, but shallow, ocean water. Through uplift and erosion, a massive, coral-rich formation of mainly limestone with some silica was exposed, and erosion began. Rainwater rich in carbonic acid was able to descend into the formation and dissolve out openings. This scenario still does not explain how the huge amounts of dissolved limestone could have been carried away.

Then scientists realized the cavern area is underlain with oil and gas deposits. In those deposits live bacteria that just love to eat oil that is rich in sulfur. These bacteria exude hydrogen sulfide gas as a byproduct of digestion. This gas worked its way up until it encountered the water descending from the surface. Instantly, a chemical reaction occurred, and sulfuric acid was formed. Sulfuric acid is one of the more corrosive acids. We produce more of it for industrial use than any other acid. The sulfuric acid did the job of dissolving the limestone and enlarging the galleries and passageways of the cave.

The clue that pointed scientists to the evidence of sulfuric acid formation is one of our favorite sulfur-bearing minerals, gypsum. Calcium is a product of dissolved limestone, and sulfate is a sulfur-oxygen chemical radical. Together, they form gypsum, a hydrous calcium sulfate. Huge deposits of this sulfate were found in the cave and could not be explained until they were shown to be a byproduct of the sulfuric acid etching away the limestone.

To produce sulfuric acid for industrial use, we used to bubble sulfur gases through water or burn pyrite, an iron sulfide mineral. The problem with both methods was that excess sulfur fumes escaped into the atmosphere, seriously polluting it. Now, environmental regulations force smelters and power plants to "scrub" the stack gases, capturing the gases by pushing them through water/filter units and liquefying the sulfur so it does not escape. This sulfur-charged liquid can be turned into sulfuric acid or even solid sulfur, both of which can be sold for a profit.

The iron sulfide mineral pyrite is an iron mineral that is common in coal deposits and in many sulfide ore deposits. It may contain gold sometimes, but it is normally mined for its iron and sulfur. In the old days of indiscriminate mining, huge deposits of iron pyrite were worked at places like Rio Tinto, Spain, and Ducktown, Tennessee. These deposits were blasted into crushed piles, then simply set in a fire in the open air and roasted to break down the pyrite. The fumes from roasting were so noxious that the land

was ruined for miles around; vegetation ceased to grow and lakes were polluted with acid rain. Today, the United States and Spain have pollution restrictions that prevent this damage.

Coal deposits are often rich enough in sulfur for some minerals to have formed. The lovely pyrite (iron disulfide) suns from the coal mines of southern Illinois result from the combination of sulfur and iron in the coal deposit. The prefix "di-" indicates that two sulfur atoms join with one iron atom.

The most important group of minerals containing sulfur is the sulfides. When we mine ore, we call the metal sulfides the "primary ore minerals" because they form in the earth before any other type of mineral in the deposit. Proof of this lies with the black smokers we have found on the floor of the ocean. The superheated water circulating within the faulted section of the earth's crust dissolves out metals and brings them to the surface of the ocean floor in a geyserlike action. As soon as the black, metal-rich waters hit the cold ocean water, they precipitate, depositing marvelously rich sulfide minerals like iron sulfide, copper iron sulfide, lead sulfide, and zinc sulfide. We have known the primary minerals in an ore deposit are sulfides, but black smokers are visual proof of that creative action.

Sulfides are referred to as primary minerals because they originate in the earth. They tend to be simple compounds of a metal and sulfur. A host of metals can combine with sulfur; the most common include iron, copper, zinc and lead. Silver, cobalt and nickel, along with other, less common, but important metals, also form sulfides. Sulfides tend to form at fairly high temperatures.

A second group of metal sulfides forms at somewhat lower temperatures than sulfides. We call them sulfosalts because they are more complex and less common than sulfides, but still very useful compounds. They are usually primary minerals, and less often secondary minerals. The silver minerals proustite and pyrargyrite are examples of exceedingly important sulfosalts.

Finally, a third group of sulfur minerals that forms from the sulfides and sulfosalts is called sulfates. These secondary minerals form when sulfides and sulfosalts break down, releasing sulfur to join with oxygen to create the sulfate radical. This joins with any one of the metal elements to form a metal sulfate like barite, celestite or gypsum. Sulfates form at yet lower temperatures than sulfosalts, often through the action of weathering. Gypsum is one of the very common forms of sulfate. This is evident in the sulfur deposits formed through the weathering of marl and limestone, as at Maybee and Scofield.

As interesting as these deposits are to collectors, the world's really great source of beautifully crystallized sulfur from marl/limestone deposits is the Island of Sicily. Long known for its volcanic emanations, Sicily has yielded magnificent sulfur crystal specimens, most of which are closely associated with calcite, aragonite, selenite gypsum, and celestite. Combinations of two or more of these species in very attractive specimens have been produced in quantity there.

Sulfur from Sicily is often associated with, and even coated with, calcite.

Sicilian sulfur tends to be typically bipyramidal in crystals ranging from a fraction of an inch to well over an inch. Tight clusters of intergrown Sicilian sulfurs can be seen on display in most of the world's museums. Some specimens have just a single textbook-perfect crystal on a white calcite background. Others have a nice scattering of yellow crystals on calcite. The calcite is almost always small dogtooth crystals. These completely cover the matrix, which is often an undulating mass of marl or limestone. The white calcite is a perfect setting for the sulfur crystals. Under the ultraviolet lamp, this calcite responds a lovely pink, or sometimes blue.

Even more exciting are the aragonite sixling specimens from Sicily that sometimes enclose some sulfur, but more often form sharp 1- and 2-inch pseudohexagonal crystals that are classic examples of this twinning habit. The aragonite can be 2 inches or longer and in clusters of several crystals. Some aragonite crystals are over an inch wide. One exciting form of aragonite has been replaced by calcite, resulting in plates of 1- and 2-inch-wide aragonites a foot or more across that are completely replaced by tiny dogtooth calcite crystals. Such specimens are a wonder of color under the UV lamp. The aragonite is always phosphorescent, glowing a soft, strong greenish color after the lamp is shut off.

Selenite from Sicily can be found enclosing sulfur crystals or as water-clear, textbook monoclinic crystals. The ideal specimens are those that consist of aragonite, selenite and sulfur in fine crystals, all resting on a plate of small dogtooth calcite prisms. Such specimens are eagerly sought, as they are not only the finest examples of sulfur specimens, but are now considered modern classics.

One problem with sulfur specimens from Sicily is locality information. There have been some name changes (i.e., Girgenti, now Agrigento). I'm sure some specimens have been credited to a locality so as to mask where they actually came from. Local collectors have been burrowing into the deposits to obtain specimens and sometimes prefer that their activities be kept quiet. In any event, if you want to add a choice sulfur specimen to your collection, you most likely will find a Sicilian sulfur much to your liking.

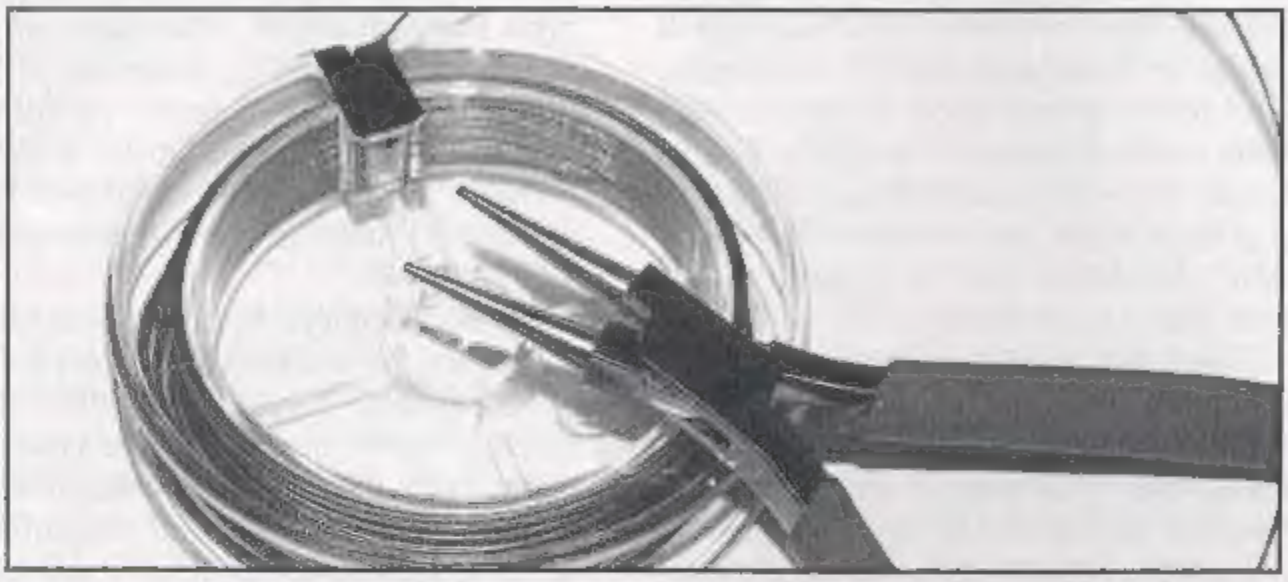
A word of caution: As the production of fine Sicilian sulfur specimens has tapered off, the production of sulfur crystals in the laboratory has increased. The few lab-grown sulfurs I've examined are too perfect and lack the normal associations you would expect from Sicilian sulfurs. Frequent visits to shows and diligent searching of dealers' shelves should yield a nice Sicilian classic sulfur to the collect or who is patient and knows what to look for.

Regardless of its origins, a fine sulfur crystal is a good example of a dipyramidal crystal and a good addition of color to your mineral shelf.

Shop Talk

by William A. Kappele

Reader Ingenuity



Irvin Gates, of Macon, Missouri, is in his 80s and still cranking out home-built designs. This time, he has come up with a truly unique faceting machine. Now, this machine is not going to put the modern, commercial digital wonders out of business, but wait until you see how it came about.

A while back, he picked up an old key-making machine at a garage sale. When he got it home, he cleaned it up, pulled out the shaft and reversed it, and attached a fine stone. At this point, Irvin had a sort of vertical lap machine.

To hold the stone and to provide adjustment, he bolted a 4-inch by 4-inch square of ¼-inch steel plate to the base of the machine. This plate provides a platform for a large magnet with a ½-inch-diameter by 6-foot-tall steel "mast." To the mast, Ivin fastened a 5/16-inch-diameter by 4-inch-long steel rod that can be moved up and down the mast and locked in any position by a thumbscrew.

To this rod, he fastened another of the same size at a right angle. It can be adjusted, rotated and locked in any position with a thumbscrew. Finally, he attached a rod that serves as the dop in the same manner. He is currently in the process of designing a protractor, index gear, or other device to get the necessary accuracy.

What would the key machine manufacturer think?

Another long-time reader whose efforts have been seen in this column many times is Moe Mechling, from Steubenville, Ohio. He has come up with a method of mounting cabochons that is simple and inexpensive, and shows off the stone with little distracting metalwork. It is lightweight, so it is ideal for large stones, which, if set in a cast mounting, might well cause the wearer back or neck problems.

The mount is made by cutting a shallow groove around the perimeter of the cab and fitting a #12 or #14 gold or silver wire into it. The preform is ground with the perimeter edge 90 degrees to the back to make cutting the groove more accurate. A simple jig made from a piece of aluminum angle, either fastened in the vise or bolted to the saw table, will make cutting the groove easier.

The bezel is made by loosely fitting the wire around the stone, leaving it about 1/8 inch too long at the joint. Moe makes a jump ring from the same size wire and a bail from 20 gauge sheet. He then anneals the whole thing on a Perfection soldering block. He fits the wire carefully around the stone in the groove, marks the ends, and cuts the excess off.

He removes the stone, slips the bail over the wire, and places it on the side of the wire away from the top joints. Next, he solders, anneals, pickles, rinses and dries the bezel wire, jump ring, and bail.

Moe files the bezel wire at the solder joint to fit the curve of the jump ring, lines up the jump ring solder joint with the bezel solder joint, and solders the two with enough solder to form a nice fillet. Then he saws through the bezel and jump ring at the ring joint, pulls the sides apart, and pulls the bail up through the slot into the jump ring. The stone is fitted, starting at the bottom, and the bezel is closed using needle-nose pliers.

Thanks, Moe. Sorry to be so long in getting this into print.

Please feel free to contact me if you have a suggestion or comment about this or any of my Shop Talk columns. My e-mail is quappelle@cox.net, or write to me at 25231 Pericia Dr., Mission Viejo, CA 92691.

FIELD TRIP

Great Salt Plains Selenite

Collecting in Alfalfa County, Oklahoma

Story and Photos by Kenneth H. Rohn

Salt brine forms crystals on the surfaces of the interconnected selenite crystals.

It was a beautiful autumn day as Betty Carol and I drove west on U.S. Highway 60/64 in Oklahoma. Our destination was The Great Salt Plains National Wildlife Refuge in Alfalfa County. We had spent the past several days in Arkansas, where I was covering the World's Championship Quartz Crystal Dig in the Ouachita Mountains. Now, several days later and a good distance from Arkansas, we were close to our destination southeast of the town of Cherokee, Oklahoma. We looked forward to some very exciting and different selenite collecting.

Oklahoma, with a total land area of 69,919 square miles and a population of 3,523,553, was admitted into the Union in 1907 as our 46th state. It is one of our biggest oil and natural gas producers. It is also farm and cattle country. The scenery is spectacular.

This complex mass of selenite crystals was carefully removed from the mud of the Great Salt Plains.

The hour-glass inner structure of the selenite is due to the influence of foreign particles during formation.

The state suffered from serious drought conditions during the late 1920s and '30s. In later years, irrigation and improved conservation methods boosted the economy to its present-day height.

The Salt Plains in north-central Oklahoma are immense. They are completely flat, consisting of very sticky mud covered with a thin saline solution that often turns snow-white during the hot months. The white substance that dries on the surface is sodium chloride, ordinary table salt. Salt in large quantities was deposited here when a sea covered this land millions of years ago. This crystalline substance in solution continually works its way up through the overburden of mud and sand, and when conditions are right, it dries as a very thin layer of salt.

The plains are seven miles long and three miles wide. As you approach on U.S. Highway 64, this gigantic, perfectly flat area devoid of any vegetation is hidden from sight by hilly terrain, including a great number of trees along the perimeter.

The northern tip of the plains lies approximately 30 miles south of the Kansas border and is surrounded by highways. This makes it convenient to reach from any point of interest in the area. State Route 11 dissects the northern tip going east and west, while state Route 8 borders it on the west. On the eastern side, Great Salt Plains State Park is situated on state Route 38, midway between the town of Jet and the junction of state Route 11, on the shore of Great Salt Plains Lake.

I had visited the state park several months earlier, during the middle of winter. I was on my way back from a successful collecting trip in Texas, and spent a day investigating this part of the country for future reference. The selenite collecting area was closed for the season, but the state park was open to campers.

It was cool enough to wear a sweater or jacket, but it was a bright, sunny day, and quite warm for autumn. The campground has a wonderful panorama of the lake. The bird sanctuary neighbors the park and one can often see any number of water fowl and migratory birds feeding and resting on the water and shore of this large impoundment. Officially known as the Great Salt Plains Reservoir, it was constructed in 1941 by the U.S. Army Corps of Engineers.

continued on next page

Once the selenite crystals are recovered, they should be set aside to dry because they are saturated with water and fragile.

Great Salt Plains Selenite *from page 29*

Selenite is a crystal form of gypsum. Gypsum, of course, is widely used as plaster and sheathing for wallboard. When gypsum is burned at a high temperature, it turns to a white powder. Thus, we have plaster. This doesn't sound very exciting, but when you think about it, this natural phenomenon is quite outstanding. When the powder is mixed with water, it dries and hardens into a consistency quite similar to its original form. In the construction of homes and buildings, where would we be without it?

Selenite, $Ca(SO_4)\cdot H_2O$, is calcium sulfate dihydrate. With a Mohs hardness of 2, it can be easily scratched with a fingernail; the only mineral that is softer than gypsum is talc. But selenite crystals are quite beautiful and can be used in some forms of jewelry where wear is not a factor. Natural selenite crystals fashioned into a pendant or brooch can be very attractive. Single crystals have a shape that reminds me somewhat of a Roman sword; when well formed, they look remarkably like a blunt knife blade with two sharp edges.

It was early afternoon when we arrived at Cherokee. We found a hardware store, where I purchased a shovel that I had been promising myself and a pair of rubber boots. They would come in handy on the salt plains.

After registering at the local motel, we drove the few miles to the plains and investigated the area from the viewing tower at the entrance. It's vast. We could see the reflection of the clouds on the mirrorlike surface of the huge, wet areas in the distance. Even the roadway to the digging area was covered with water in many places. We both noticed that it was very quiet here; even the wind was still that afternoon. Betty Carol and I took a few pictures and decided to get an early start in the morning. We went back to Cherokee for a good night's rest.

The next morning, when we drove to the digging area, the roadway was covered with water, but we soon learned that it was only an inch or two deep at most. The base seemed solid enough when I drove through the water holes, and I found that there was nothing to be concerned about. Although we were driving Betty Carol's 4x4 Honda SUV, I believe any car could make it in without difficulty.

The digging area is quite far from the gate. I didn't check the mileage on the odometer, but I'd guess that it has to be close to a mile from the entrance point. It's a most intriguing place, flat as a table for miles in every direction.

While there, we met Jon Brock, Refuge Manager of this gigantic wildlife sanctuary. I liked him instantly. During our conversation, he told us that some of the endangered bird species that winter here had been sighted recently, including one whooping crane. This was exciting news. The sanctuary is fenced off right next to the selenite digging area and the possibility of seeing migratory birds at this time of year, one day before closing time, was good.

The selenite crystals are found in many complex configurations.

I looked out at the vast expanse before me. The dig area was pockmarked with literally thousands of holes, all the way to the fence line. I mentioned to John that a great number of people had been digging for crystals and had failed to fill their holes. He explained that when they first opened the area for collectors, rockhounds were compelled to fill them. After a bit of research, however, they learned that the holes encouraged brine flies to stay in this new environment and multiply. The flies produce a considerable amount of food for the birds, so rockhounds are no longer required to fill their holes. Birds of all species feed on the flies during nesting season. They are also easy prey for the young birds.

This is a major migration rest stop for hundreds of thousands of birds, including several species of ducks, geese, shore birds such as avocets and sandpipers, and a number of extremely shy cranes. During the months that the plains are closed (Oct. 15 to Mar. 31), the refuge is designated as critical whooping crane habitat.

Although Betty Carol and I didn't see any birds that day, we talked to another couple who did. They had been over at the state park on the eastern side of the lake, and they told us that thousands of birds were resting along the shore and in the water. At any one time, these birds can number as many as 100,000, so that would substantiate their story.

While I was getting ready, Betty Carol announced that she would act as photographer and record my actions on film. She mentioned to John with a chuckle that it was most interesting to watch me search for crystals, a task that promised to be quite muddy work.

Jon explained that the situation at this time of year was critical for the comfort of the endangered birds. He asked us to keep noise to a minimum, wished us well, and drove off.

I put on my rubber boots, took the shovel, a small scoop, and a bucket, and went out onto the salt flats. It was rather cool that morning, so I wore a light jacket. Although wet in many places, I was surprised that the surface was not at all sticky. It was like walking on a sidewalk. It remains that way until it's disturbed by digging.

The selenite crystals can be found as single small points less than an inch long, and occasionally several inches in length. They also form into complicated inter-grown crystals with innumerable shapes and forms. Crystal clusters weighing upwards of 30 pounds have been collected at times. Quite often during the process of formation, which I presume is rather brief, foreign objects such as dirt, pebbles, and even bone fragments are trapped in the selenite crystals.

continued on page 32

Great Salt Plains Selenite *from page 30*

One very interesting feature of the Great Salt Plains crystals is their unique inner coloration. Very fine particles of sand and other minerals are captured in the crystals as they grow, forming an unusual hourglass shape that is found nowhere else. When the crystal is held up to the light, this chocolate-brown phenomenon can easily be seen. The brown color is due to the influence of iron oxide in the solution.

The surprising thing about these particular selenite crystals is that they seldom form below a depth of 2 feet. You are apt to find them just below the surface, and care must be taken not to destroy them while digging a hole.

So where does one begin to dig? I knew from research that crystals do not form everywhere on the plains. Conditions have to be just right for this phenomenon to take place. As a matter of fact, the digging area is changed every two years or so to allow more crystals to form.

I picked a place at random and began to carefully dig a hole about 100 yards from the Honda. Betty Carol got the camera ready and watched me dig. When I had a hole about 3 feet in diameter and 2 feet deep, I stopped to rest. The hole rapidly began to fill with water. The bottom was very sticky and I had to work at getting my feet loose.

Try as I might, I found no crystals in the hole. I did find a number of different colored pebbles, which I deposited in the pail for later examination.

The recommended method of recovering crystals is to dig a hole and, when it begins to fill with water, use a scoop or pail to splash the water on the sides of the crater. I used my hands, although the water was very cold. If there are any crystals in the wall of the hole, they will be exposed by this washing action. They must be very gently removed because they are saturated with water and extremely fragile at this stage. They break quite easily. After they are safely removed, they can be set aside to dry.

I was wandering about close to the Honda when Jon returned. By that time I had found only a few crystals. Jon suggested we take a walk and headed for the fenced area a good distance from the vehicles. In almost every place I've collected, one has to go a bit farther away in order to get the better minerals.

Jon studied a few of the recently dug holes near the fence. Many were almost full of water. He removed one of the most perfect complex forms of selenites that I'd ever seen right near the surface. It's beautiful, with several points interconnected with several short sections of crystals. Then it was my turn. I began to find one crystal after another nearby.

A shovel, bucket and scoop are all the tools needed to recover selenite crystals.

This turned out to be a very productive location. Crystals were quite plentiful and I soon had a good representation of what can be found here. Many of the doubly terminated crystals I picked up have that unusual flat, sword blade shape.

I learned a great deal more about the Salt Plains and the wildlife that live here from Jon while collecting selenites. It was getting late when he said he had to leave, so we walked back to the vehicles. When I showed Betty Carol the fine crystals we had collected, she reminded me that I should have taken her advice and walked out farther right away.

Although it was getting late, I just had to go back out and collect a few more crystals. Try as I might, I could not find the holes that Jon and I had collected in; they all looked alike. I did, however, find another area quite a distance from the SUV and was able to collect several more very nice crystals. These were all single forms except one that was a tightly woven mass of stubby crystals almost in the shape of a ball a couple inches in diameter.

During all this time, Betty Carol had been taking photos of me collecting selenites with the digital and 35mm cameras. She also kept watching for any birds that might be in the area.

The day was coming too quickly to a close, and it was time to be on our way. It had been a most unusual adventure and a productive one. I had collected some beautiful selenite crystals and had enjoyed myself immensely.

If you visit the Great Salt Plains during the hot summer months, make it a point to wear sunglasses. The ultraviolet rays reflecting off the white surface can be brutal. Also, drink plenty of liquid, cover your head with a hat or cap, and put on a pair of water-resistant shoes.

To reach the selenite digging area from Cherokee, Oklahoma, drive three miles south on state Route 8/58 to U.S. Highway 64, turn left, and drive five miles east to the entrance gate on state Route 38. Digging is allowed from sunrise to sunset, and no permit is required. Collectors may remove up to 10 pounds of crystals, plus one large cluster, for personal use.

If you happen to be in the area during the last weekend in April, don't miss the Salt Plains National Wildlife Refuge Birding & Crystal Festival. You can join them for crystal digging contests at that time. For more information on this event, write to Salt Plains National Wildlife Refuge, Rte. 1, Box 76, Jet, OK 73749, call (580) 626-4794, or visit http://saltplains.fws.gov. ¶

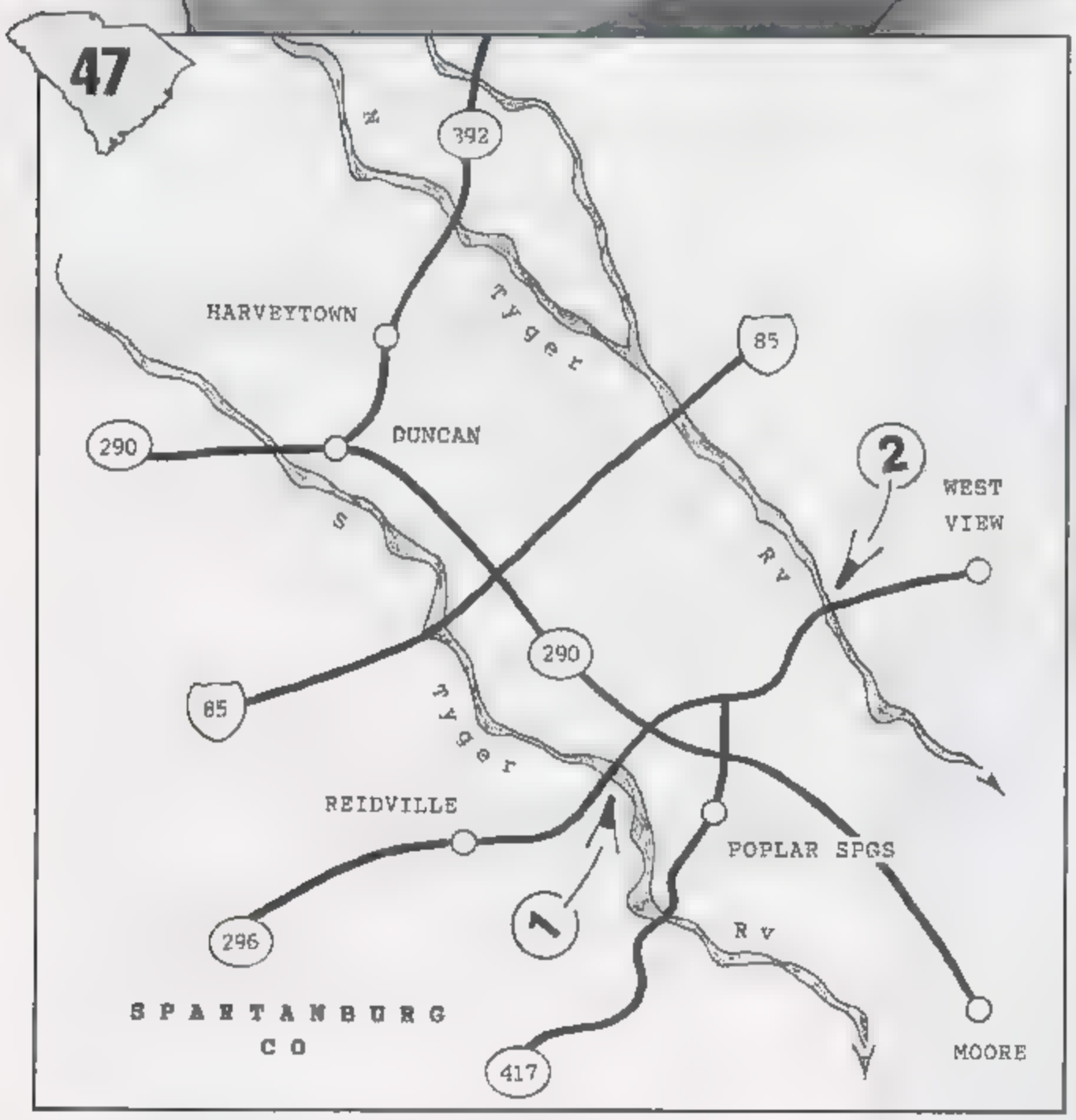
DID YOU TAKE THIS FIELD TRIP? Send a photo of your finds and a brief description of your experience to **My Field Trip, *Rock & Gem* magazine, 290 Maple Ct., Ste. 232, Ventura, CA 93003** All submissions become the property of *Rock & Gem*.

GOLD AND GEM HIGHWAYS

ROADSIDE PANNING SITES IN SOUTH CAROLINA

Part VI: Spartanburg, Union and York Counties

Story and Maps
by David and Clois Walker



SPARTANBURG COUNTY (MAP SC47)

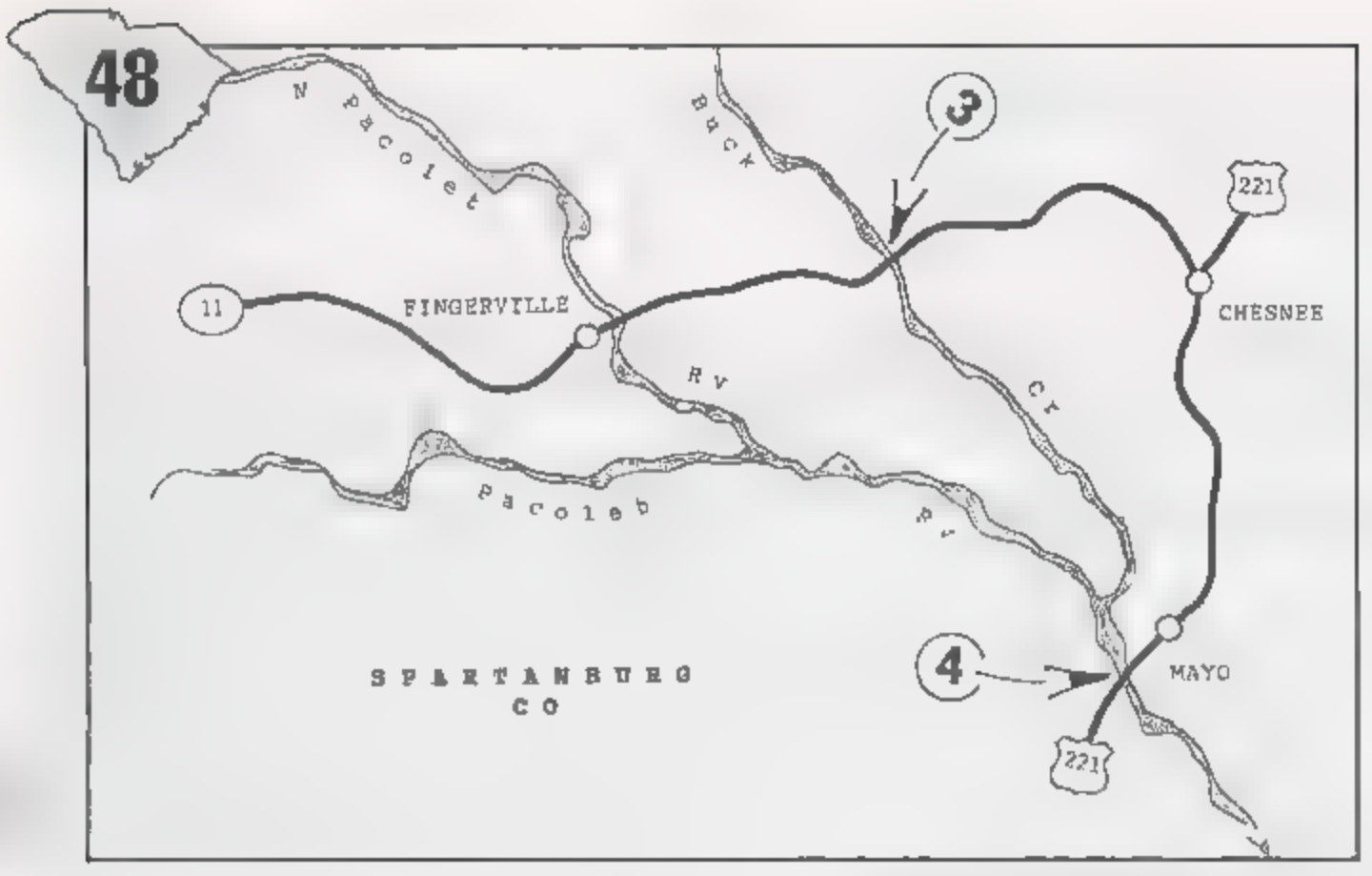
Site 1. **South Tyger River/state Route 296** crossing near **Reidville.** Vicinity finds include gold and zircon.

Site 2. **North Tyger River/U.S. Highway 296** crossing near **Westview.** Vicinity finds include gold and zircon.

This is the sixth in a series of six articles containing maps that indicate suggested panning and screening sites at South Carolina highway/stream crossings where appreciable finds have been previously reported in vicinity watersheds. The principles of erosion make it likely that minerals and gemstones have been deposited in river gravels, awaiting removal by a rockhound with a pan. This is a speculative study; whether conditions at these sites are conducive to panning activities and whether minerals can indeed be found have not been investigated.

By confining operations within government-purchased highway rights of way, panners are spared the necessity of locating and obtaining permission from adjoining property owners. However, government permission is given on a case-by-case basis. Visit the South Carolina Department of Transportation Web site, www.scdot.org/inside/engineering_directory.shtml to find the number of the local office that gives access permission and explains the extent of the right of way. Readers also run the risk of prosecution if they cross onto private land, whether purposely or inadvertently.

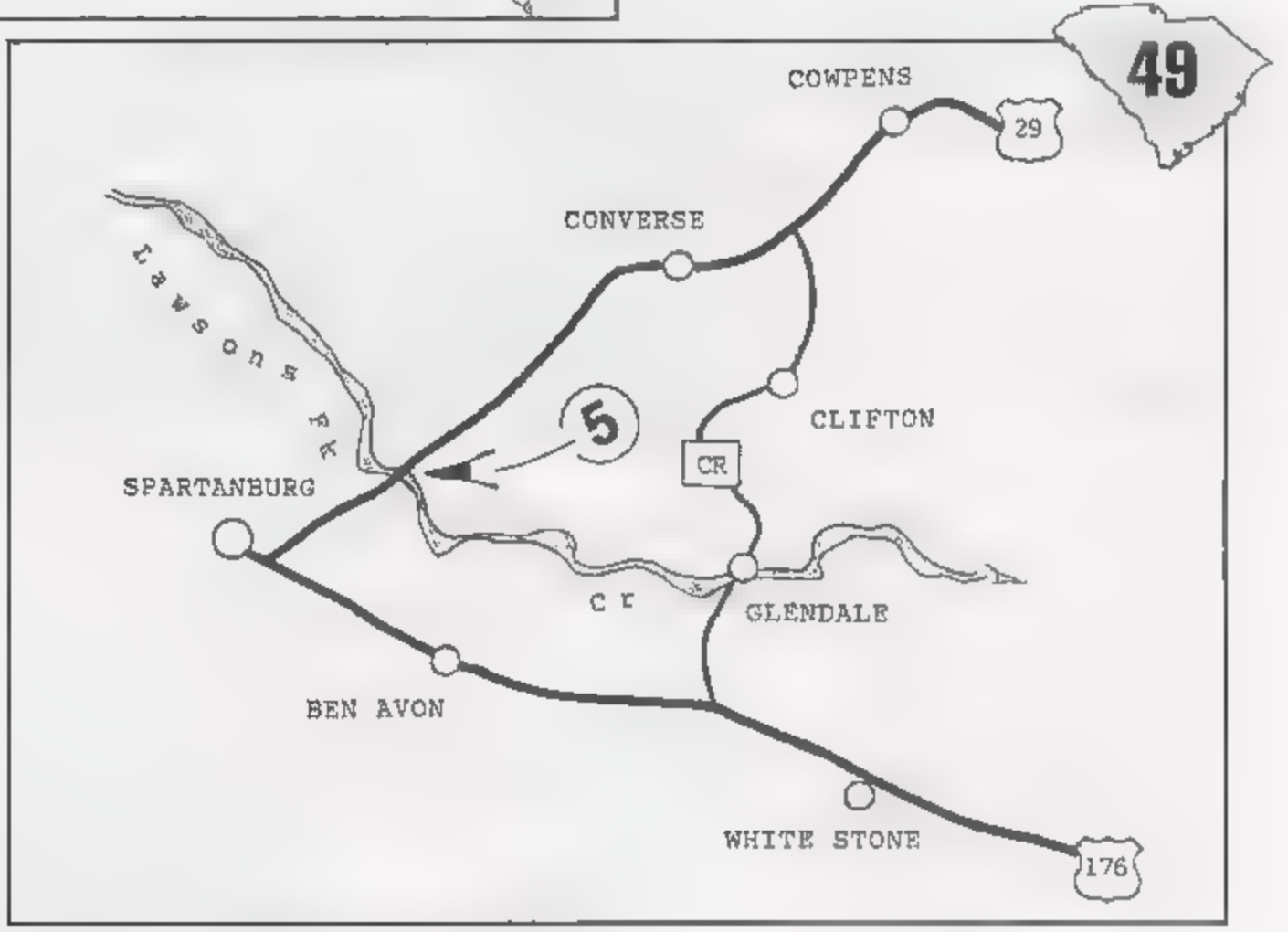
Remember to observe highway safety and environmental standards, such as parking only where designated, and using only a pan and scoop. The maps provided contain the most up-to-date information available to us, but it is advisable to consult a current state highway or county map when planning an outing, for overall orientation in the field and because highway designations have been known to change.



SPARTANBURG COUNTY
(MAP SC48)

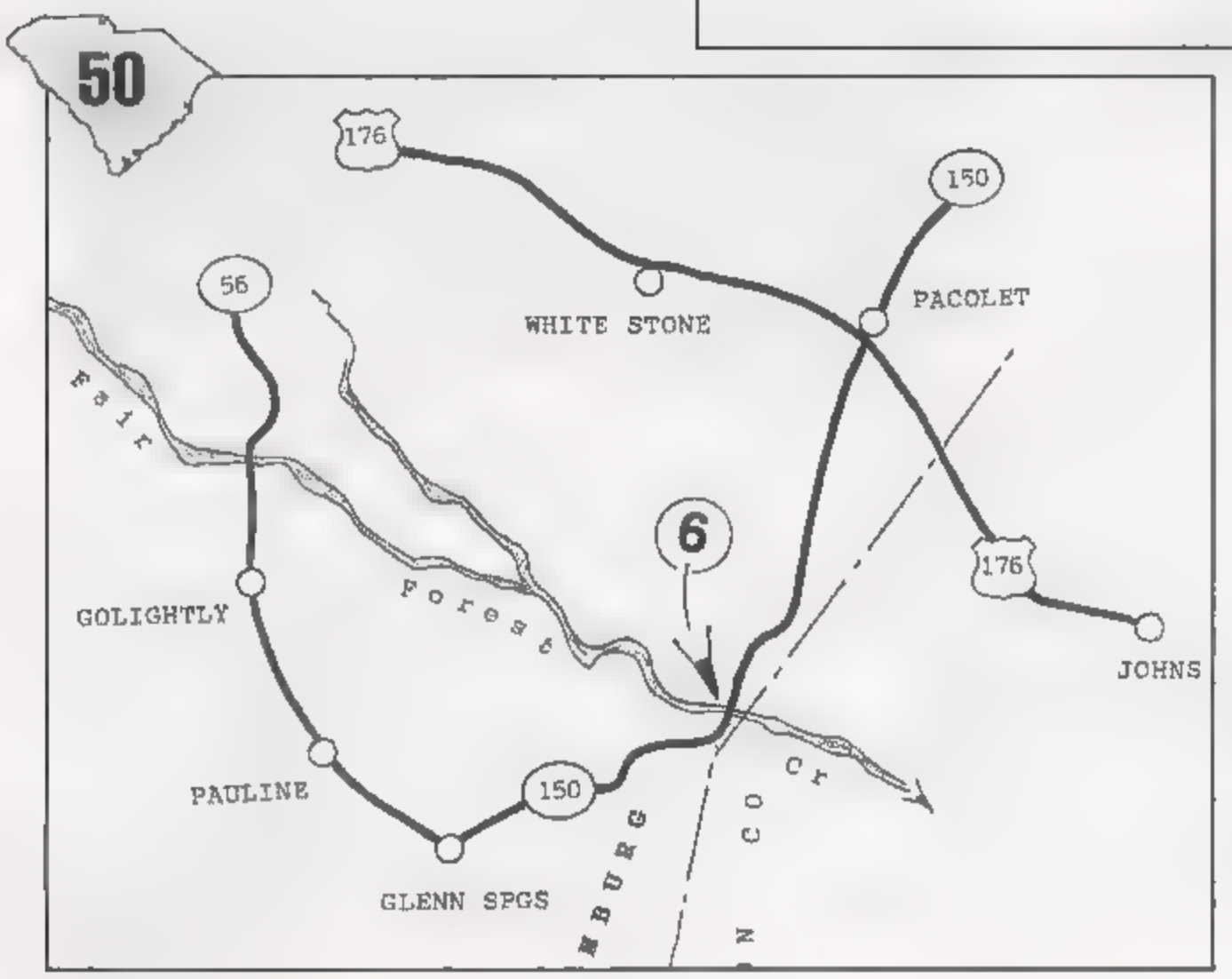
Site 3. **Buck Creek/state Route 11** crossing near **Fingerville.** Vicinity finds indicate gold potential.

Site 4. **Pacolet River/U.S. Highway 221** crossing near **Mayo.** Vicinity finds include diamond and gold



SPARTANBURG COUNTY
(MAP SC49)

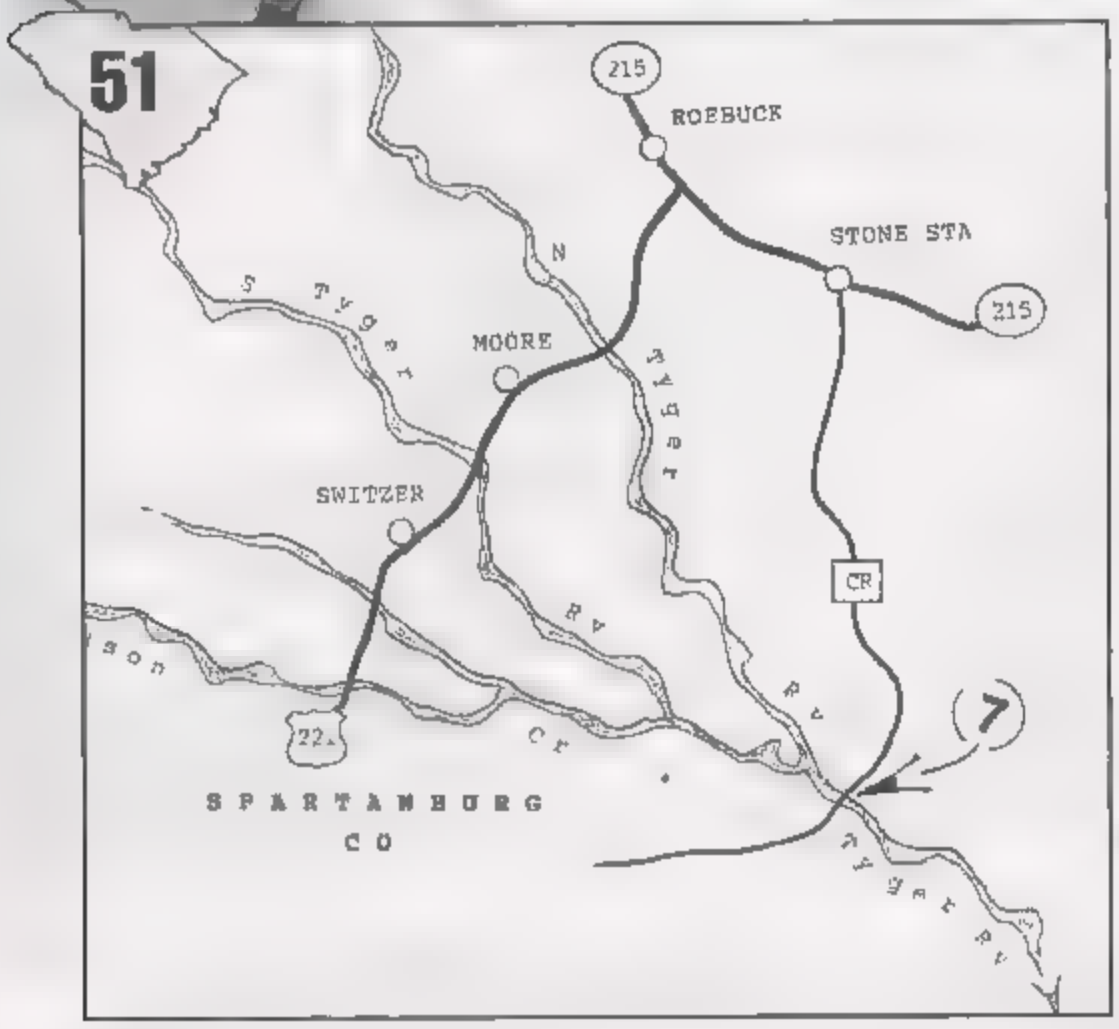
Site 5. **Lawson's Creek/U.S. Highway 29** crossing near **Spartanburg.** Vicinity finds include gold and zircon.

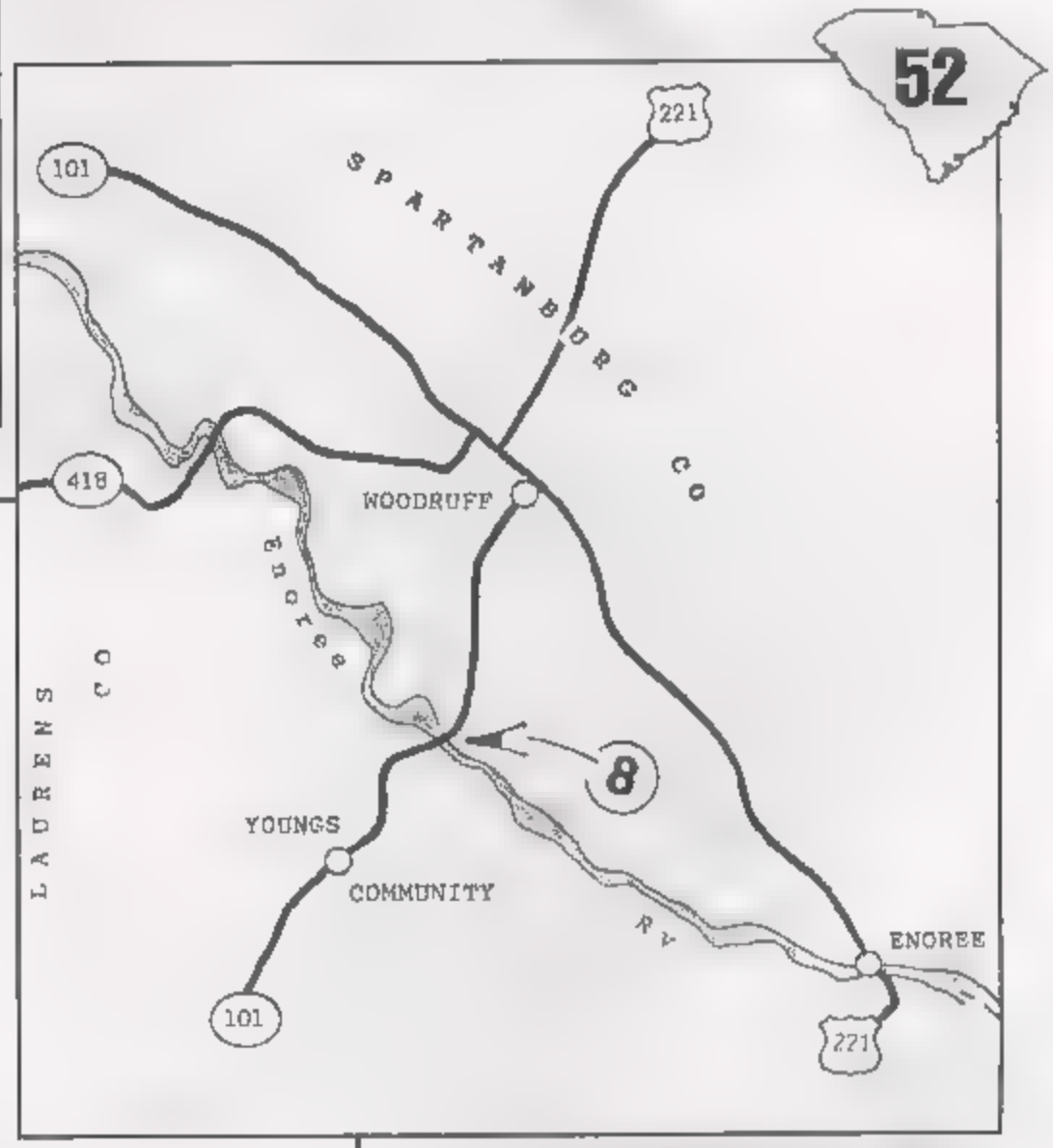


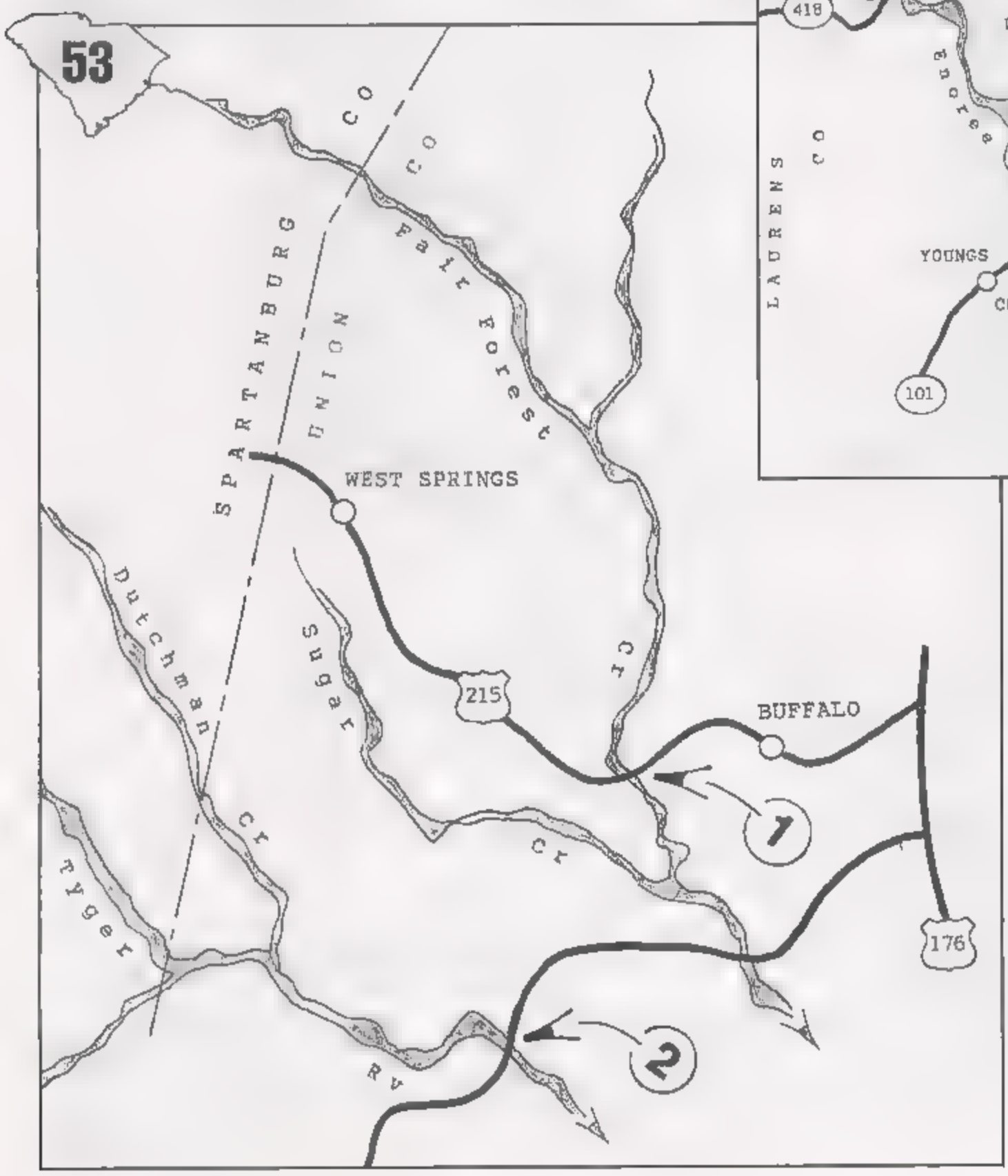
SPARTANBURG COUNTY
(MAP SC50)

Site 6. **Fair Forest Creek/state Route 150** crossing near **Glenn Springs.** Vicinity finds include diamond, gold and zircon.

continued on next page







SPARTANBURG COUNTY (MAP SC51)

Site 7. **Tyger River/County Road** crossing near **Stone Station.** Vicinity finds include diamond, gold and zircon.

SPARTANBURG COUNTY (MAP SC52)

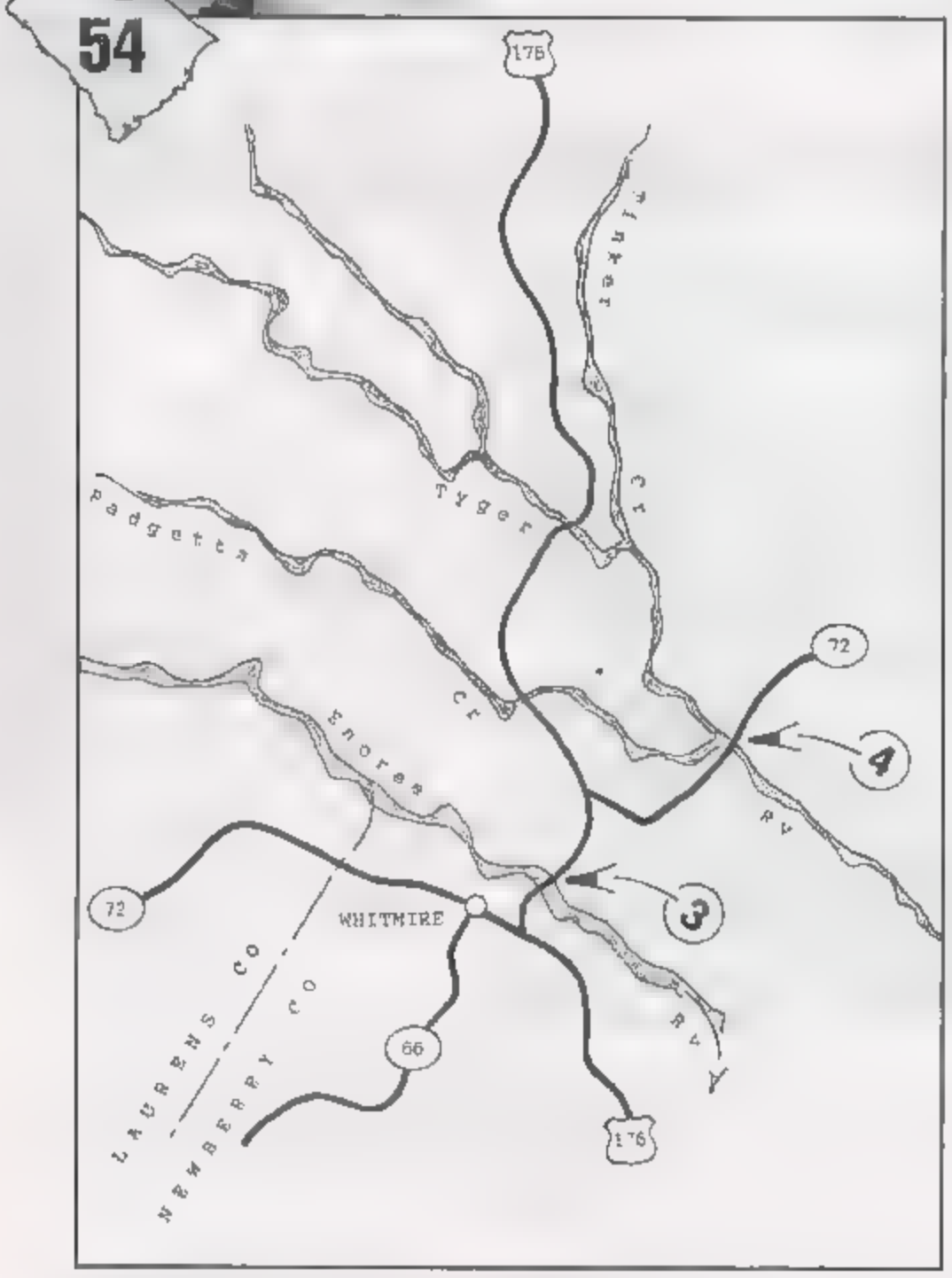
Site 8 **Enoree River/U.S. state Route 101** crossing near **Youngs.** Vicinity finds indicate gold potential.

UNION COUNTY (MAP SC53)

Site 1. **Fair Forest Creek/U.S. Highway 215** crossing near **Buffalo.** Vicinity finds indicate gold potential.

Site 2. **Tyger River/state Route 49** crossing near **Buffalo.** Vicinity finds indicate gold potential.

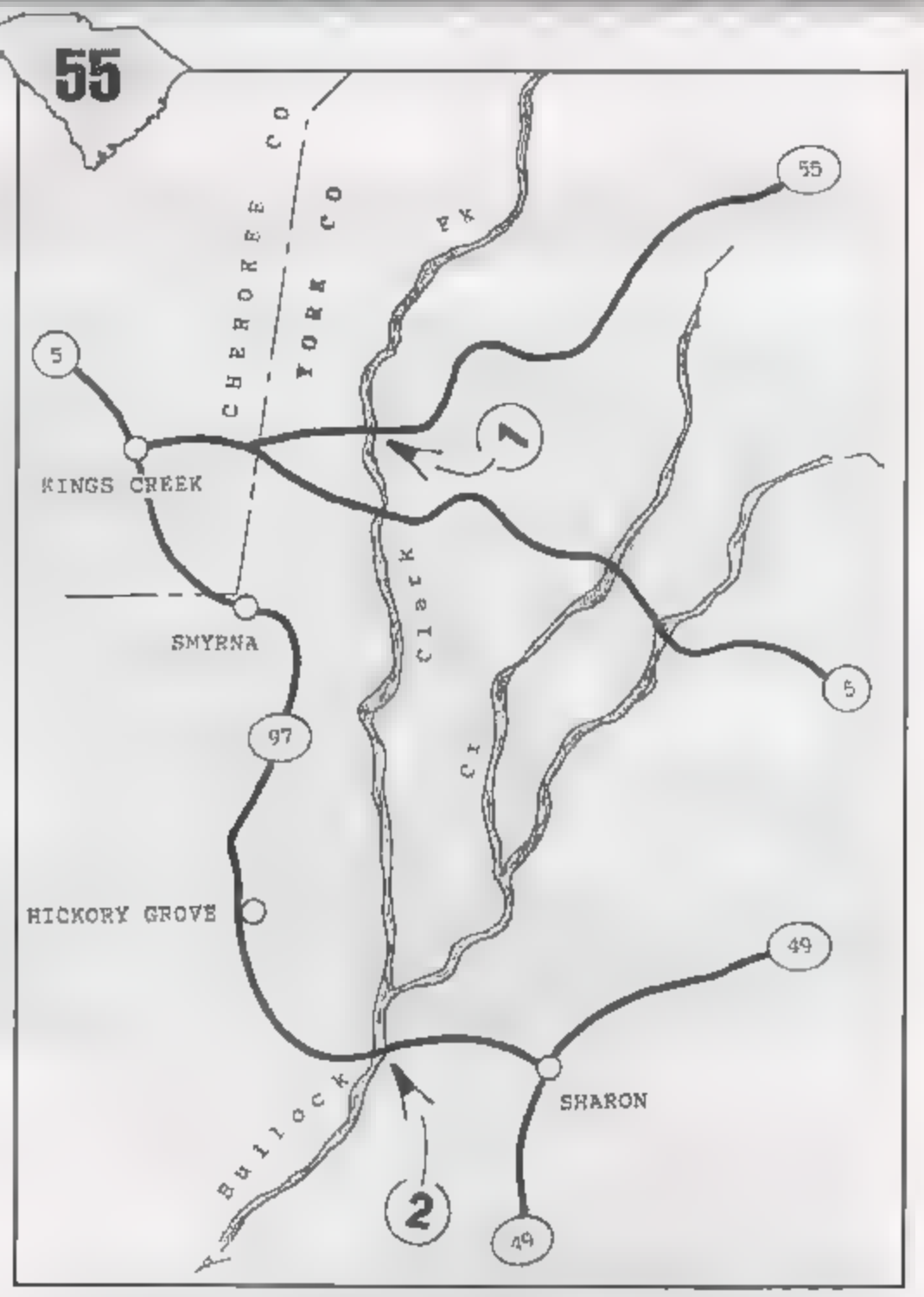
continued on page 38



UNION COUNTY (MAP SC53)

Site 3. **Enoree River/U.S. Highway 176** crossing near **Whitmore.** Vicinity finds indicate gold potential

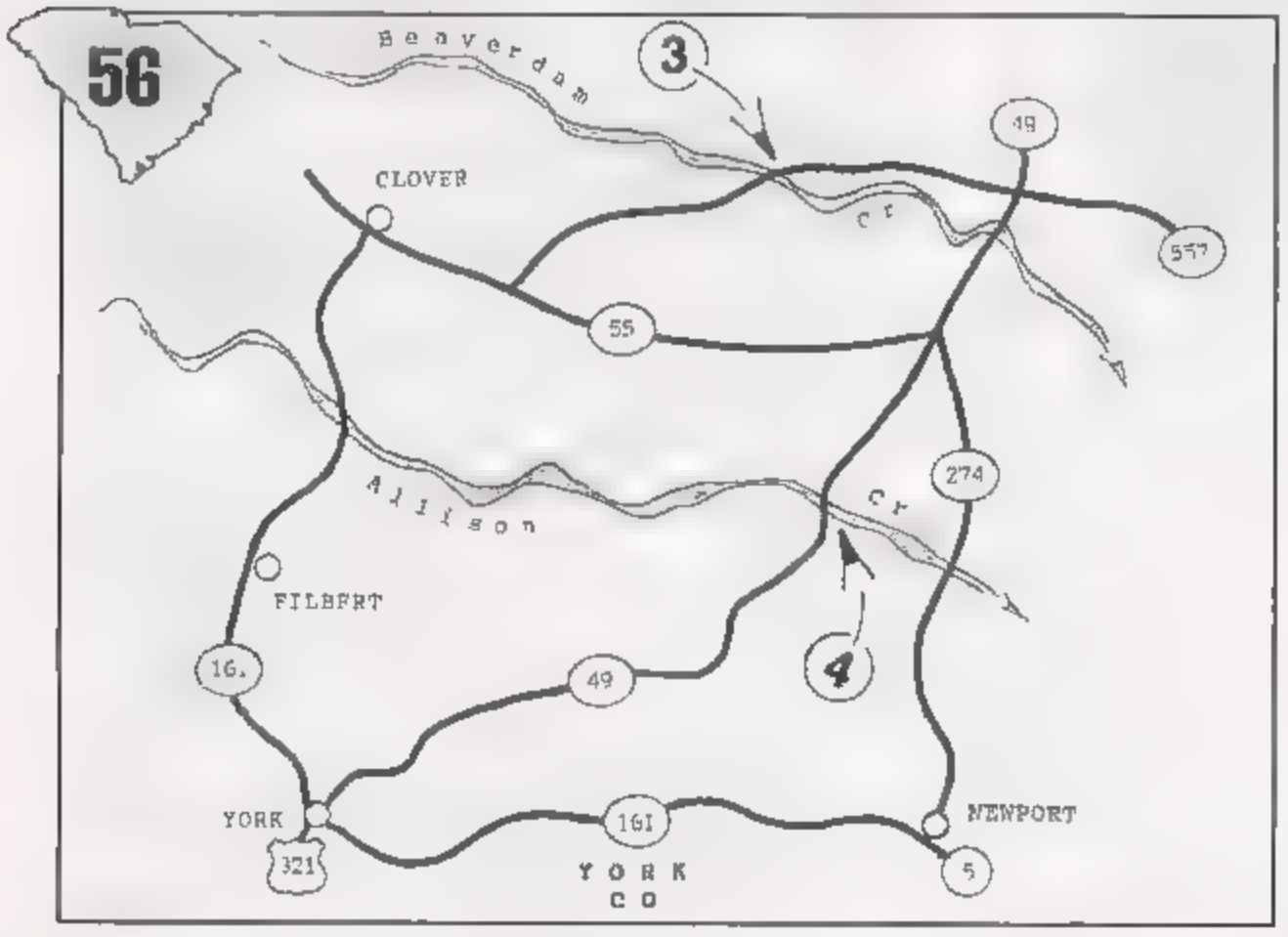
Site 4. **Tyger River/U.S. state Route 72** crossing near **Whitmire.** Vicinity finds indicate gold potential.



YORK COUNTY (MAP SC55)

Site 1. **Clark Fork/state Route 55** crossing near **Kings Creek.** Vicinity finds indicate gold potential.

Site 2. **Bullock Creek/state Route 97** crossing near **Sharon.** Vicinity finds indicate gold potential.



YORK COUNTY (MAP SC56)

Site 3. **Beaverdam Creek/state Route 557** crossing near **Clover.** Vicinity finds indicate gold potential.

Site 4. **Allison Creek/state Route 49** crossing near **York.** Vicinity finds indicate gold potential.

SUPERSAURUS

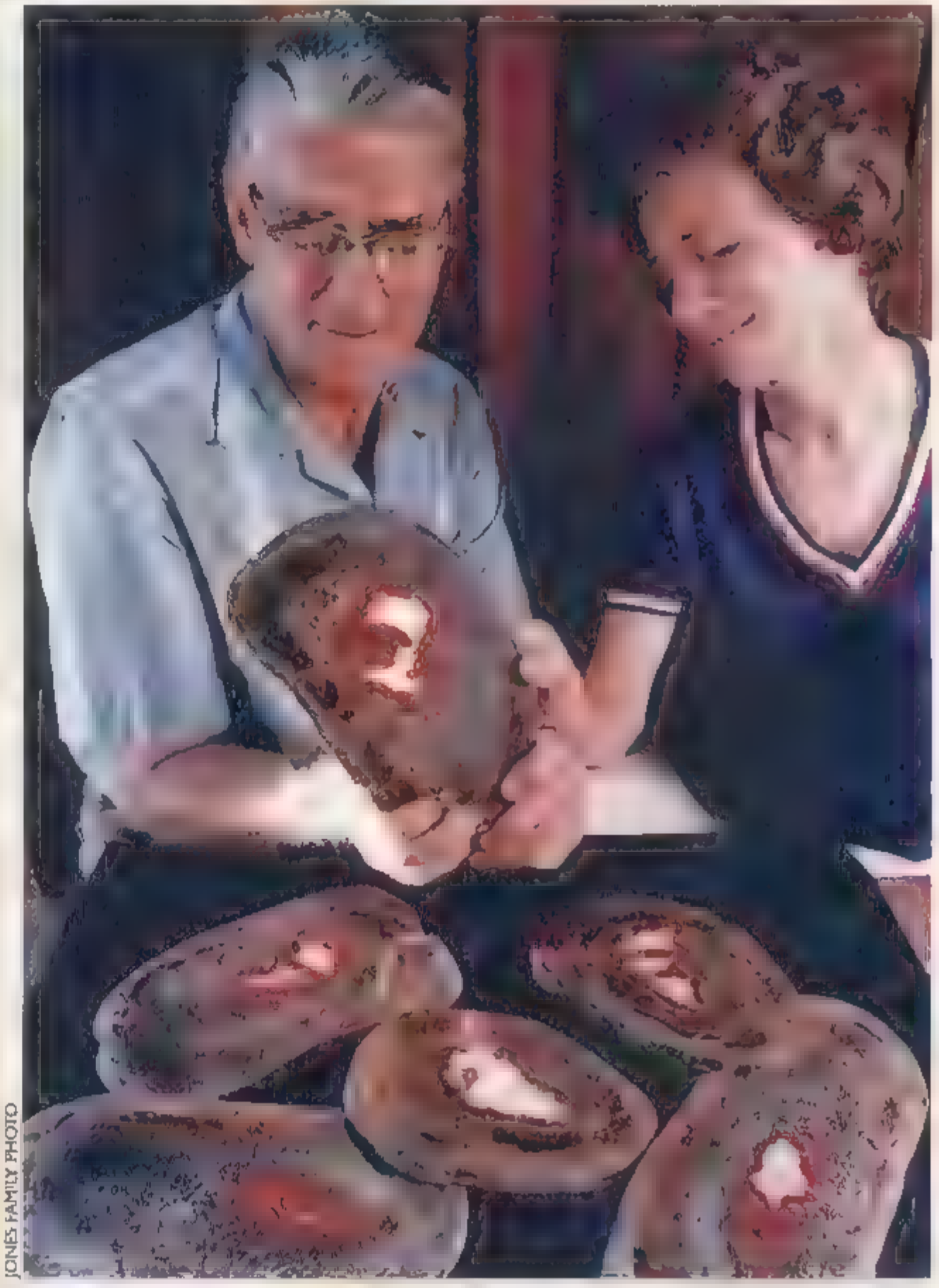
viviane

A Tribute to Vivian Jones

Story by Barbara L. Miller

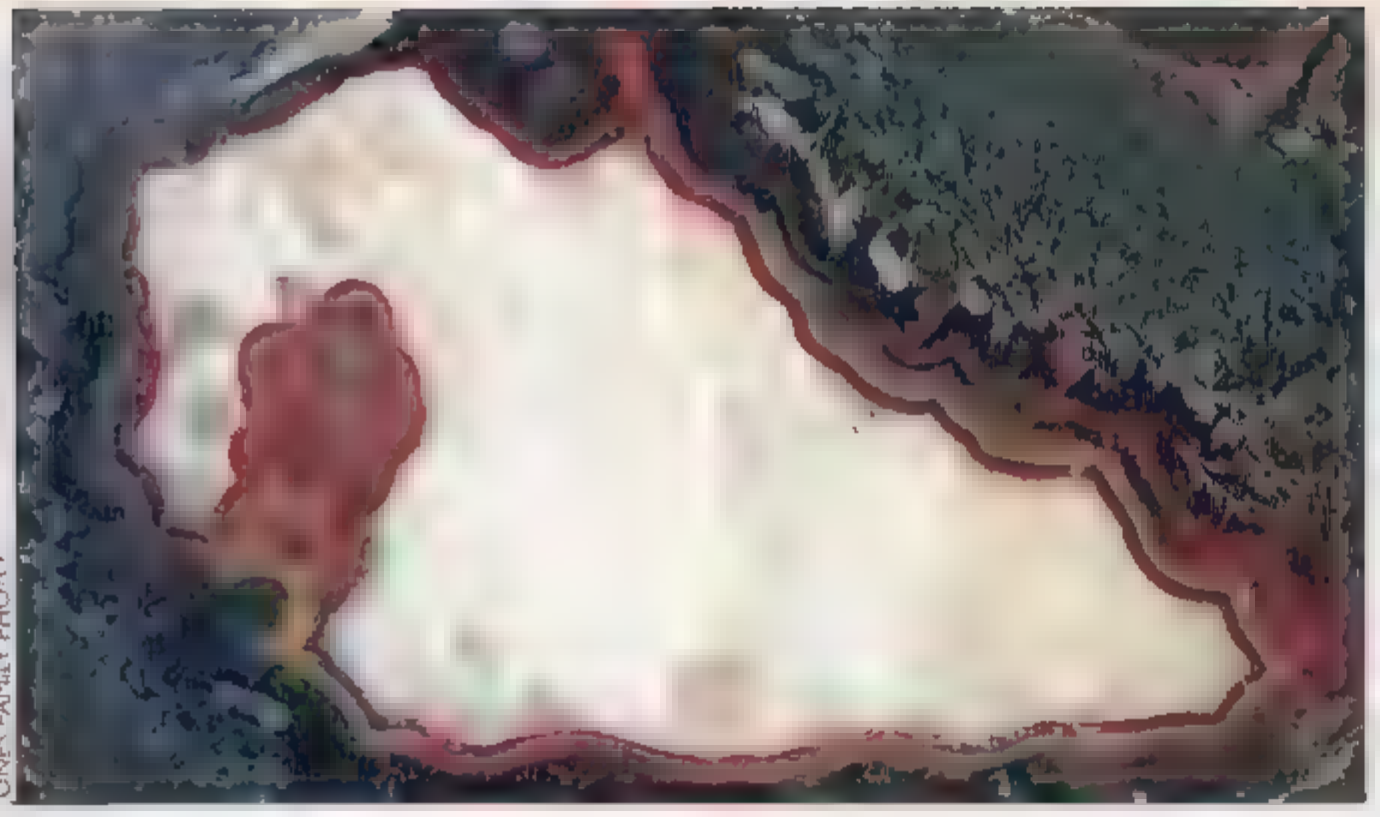
There are many pioneers in the rock- and bone-collecting hobby to whom we can pay tribute for their contributions to those who follow in their footsteps. Vivian Jones and her late husband, Eddie Jones, of Delta, Colorado, are definitely in that revered circle.

I met Vivian years ago at a rock specimen program my husband, Keith, and I gave for the local Rock Wranglers Club meeting. Vivian made a great impression when she told me about the couple's eventful time spent in the Uncompahgre National Forest and on BLM land near Delta. We discussed their interesting life, which included finding treasures and contributing to the history of the dinosaur world of western Colorado.



JONES FAMILY PHOTO

Eddie and Vivian Jones proudly display colorful dinosaur bone slabs they cut and polished.

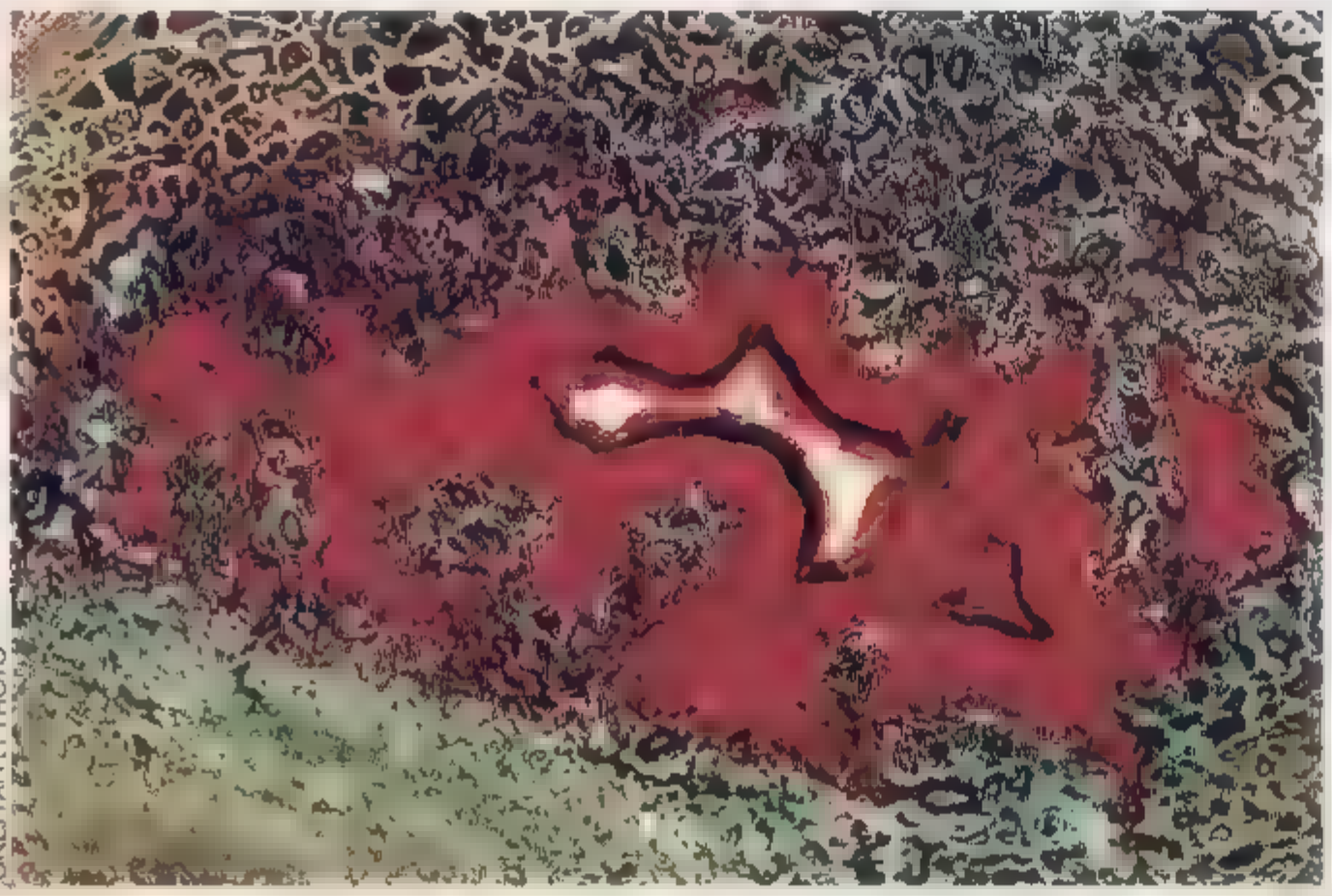


JONES FAMILY PHOTO

White agate fills the center of this red-and-green dinosaur bone specimen

JONES FAMILY PHOTO

Vivian created this sterling silver pendant using dinosaur bone cabs and a fossilized snail.



JONES FAMILY PHOTO

Eddie and Vivian Jones became intrigued with the many colors of dinosaur bone.

BARBARA L. MILLER PHOTO

Vivian has turned dinosaur bone into cabochons, jewelry, and other items over her lifetime.

To learn more of her story, we drove from Longmont, Colorado, over the passes in a snowstorm in early October 2006. We arrived in sunshine on the western slope of the Rockies for an interview.

Vivian Falkenburg Jones' grandparents arrived in Colorado in a covered wagon. Their wagon train members were the first to settle in the valley west of the Wet Mountains. Grandfather Falkenburg was a merchant in the newly settled town of Westcliffe and was very interested in silver mining. He grubstaked miners and became the owner of several mines when the miners moved on. Vivian's father inherited the family mines north of Westcliffe.

Vivian was born in 1919. As a teenager, she accompanied her sister down the 90-foot ladder to work in the mine, "mucking out" the waste rock and dirt into the windlass bucket. Vivian said it was a thrill to watch holes being drilled and dynamite inserted to blast a new section of the mine wall.

Vivian met and married Eddie Jones, who had worked in sawmills and a mine in Georgetown, Colorado. Rock hunting became one of his favorite pastimes. It was a natural progression for a girl raised in a mining family in the Wet Mountains to go into the wilderness with her husband to hunt agates and arrowheads. Eddie, Vivian and their children moved to Delta in 1946 and opened the Jones Lumber Co., which they operated for the next 58 years.

continued on next page

Supersaurus viviane *from page 4*

Rock hunting and picnics were a family enjoyment while their eight children were young. While searching on Black Mesa in Curecanti Canyon, east of Crawford, Colorado, they found beautiful agate. They named it Curecanti agate, and it is still hunted by rock lovers today.

During the uranium boom in the mid-1950s, the Joneses staked 27 claims in the Potter Canyon area of the Uncompahgre National Forest southwest of Delta. To get to their claims, they had to cross Potter Creek 52 times. That proved very dangerous in the spring or after a thunderstorm.

Eddie and Vivian used a Geiger counter to locate uranium on their claims and were getting positive readings from something they didn't expect – dinosaur bone! They became intrigued with the many colors of bone, and thus began their search.

Vivian found a 7-foot bone almost in Potters Basin that was identified as the humerus, or upper arm bone, of a *Brachiosaurus*, a Jurassic sauropod dinosaur estimated to have weighed over 55 tons. This giant had a very long neck and small head. It walked on all fours, and its front legs were much longer than its hind legs. Vivian donated the bone to the Smithsonian in Washington, D.C.

While visiting the Smithsonian on the day President John F. Kennedy was assassinated, Dr. Jim A. Jensen of Brigham Young University (BYU), a Utah paleontologist, saw the huge bone. He asked who found it and received minimal information, due to everyone being in a state of shock. He was told, "Someone near Grand Junction, Colorado, with a common name and associated with wood." Upon inquiring in Grand Junction, he learned it was Eddie and Vivian Jones in Delta and went to see them. They took Dr. Jensen, aka "Dinosaur Jim," to Potters Basin, where Vivian had found the huge bone. They found a hip and foot bone, but no more. Dr. Jensen believed the remainder of the 55-ton *Brachiosaurus* had disintegrated over the centuries. He asked to be contacted if the Joneses found other good specimens. Eddie and Vivian gathered some surface bone on their claims, but did not dig, due to their respect for important historical finds.

The couple's collection of agates and dinosaur bone increased. Vivian had seen a polished chunk of bone and knew what she wanted to do with their treasures. They bought lapidary equipment and, following basic instructions,

she began a career of cutting and polishing agate and bone. Silversmithing was her next learning experience. Eddie and Vivian sold rough rock slices and her jewelry for many years. Utilizing many colors of dinosaur bone, Vivian made cabochons and designed silver mountings to enhance them. She still has her favorite creation, which displays eight cabs of various colors of bone inset in silver. When she wears the pendant, it draws many compliments.

The Joneses joined the Delta County Rock Wranglers Club three months after it was founded in August 1966. Vivian said that was the next thing to being charter members. She is still active in the club today.

In 1967, Eddie found five vertebrae protruding from a bank in the Star Mesa area southwest of Delta. He and Vivian discussed his new find and called Dr. Jensen at BYU. Upon his arrival, they took him to the site, and after seeing the vertebrae in place, he said he wanted to excavate. That presented a problem: There was no passable road to the site. The Joneses obtained consent from the BLM and worked with that agency to build 18 miles of road that began at the head of Dominguez Canyon and went down to the Dominguez-Jones site.

The BYU crew and Dr. Jensen began excavation. They uncovered an almost complete, articulated (bones fossilized in place) skeleton of a *Camarasaurus*. The small head and a leg bone of this giant were never found. The Earth Science Museum in Provo, Utah, has this 50-foot dinosaur skeleton.

In 1968, the Joneses were searching an area across the canyon from Star Mesa. Vivian said it was like walking into a treasure trove of dinosaur bone. They named the area Cactus Park Graveyard. Dr. Jensen and other knowledgeable people in the paleontology field said this area had some of the best preserved and highest quality bone they had found. Dr. Jensen collected an array of sauropod bones, almost all belonging to juveniles of the sauropod dinosaur *Apatosaurus*.

For their Memorial Day outing in 1971, the Joneses took their trailer and camped on Forest Service land near Dry Mesa. Vivian said they normally didn't hunt bone there because there were few Morrison Formation outcrops; they had found more outcrops on BLM land at a lower elevation. Dinosaur bone and skeletons were normally found in the Morrison strata. They saw one of the outcrops and went

JONES FAMILY PHOTO

Eddie and Vivian Jones (left) look on as Dr. Jensen measures a 9-foot scapula bone at Dry Mesa Quarry near Delta, Colorado.

to investigate. Vivian found an unusual round bone, like none they had ever seen, approximately 4 inches in diameter (larger at the base with a smaller top) and about 6 inches tall. When Dr. Jensen visited their home, they showed it to him. He excitedly told them it was a giant carnivore toe bone in perfect condition. This carnivore was almost as large as the *Tyrannosaurus rex* and was later named *Torvosaurus*, a new genus. Jensen was on his way to Cañon City, Colorado, for excavation work, but wanted to see where the toe bone had been found. Naturally, the Joneses took him to the location.

After some surface digging uphill from the Joneses' find, he found a leg bone. Dr. Jensen said he wanted to bring excavation equipment and a film crew to Dry Mesa. The site overlooked Escalante Canyon and the middle fork of the Escalante River. During the winter, the paleontologist obtained the required permits to begin excavation the next spring.

In early April 1972, the BYU excavation team and film crew arrived in Delta for the trek up to Dry Mesa. Vivian thought it was too early in the spring to drive 30 miles to the 7,500 foot elevation of Dry Mesa; a snowstorm the night before had made the roads muddy. She said the trip was a hair-raising experience. When she looked back at their camping trailer, the wheels were skidding—not turning! The optimistic Eddie said, "It's just a little ways further. We'll make it!" even though it was still six miles to the future quarry site.

The film crew enjoyed every mile of the trip, saying it was great material. The Joneses and most of the crew made it to the quarry site, but Jensen's small camping trailer broke an axle and he had to leave it along the road. The next morning, he returned to Delta to purchase replacement parts. After repairs were made, he and the trailer completed the journey to the quarry site.

The overburden at the new quarry was first removed with a bulldozer down to the bone level. Then the crew began their work with shovels, picks and paintbrushes. The *Torvosaurus* was an important find for BYU, as it was the largest carnivore found in the old Morrison formation. It is on display at the North American Museum of Ancient Life, located in Lehi, Utah (www.thanksgivingpoint.com/museum/).

During excavation, Jensen's son found the huge, 8-foot-long scapula of another species. Reporters from *National Geographic*, *Life* magazine, the *Wall Street Journal*, and other publications appeared to record the important event. A mate to that scapula and one-third of the animal's other remains were removed much later. Jensen named the previously unknown dinosaur *Supersaurus viviane*, honoring Vivian for finding the first Torvosaurus toe bone, which led to many dinosaur discoveries.

continued on next page

The *Supersaurus* bones unearthed at Dry Mesa and an articulated skeleton of the dinosaur are displayed in the Museum of Ancient Life. According to Jeff Bond, a docent at the museum, the exhibit text states the dinosaur was estimated at over 110 feet long and weighed 40 to 45 tons. Bond said the mate to the first 8-foot scapula remained in the ground for five years until other bones that prevented its extraction could be removed. Since the large, flat bone would be difficult to transport, it was cut into three pieces in order to haul it out of the quarry. The pelvis was discovered in 1988.

Several years later, Jensen uncovered a larger scapula at Dry Mesa Quarry, measuring 9 feet long. He named it *Ultrasaurus*, which was not a valid genus. It is now known as *Brachiosaurus* according to Dr. Brooks Britt, a paleontologist at BYU. It was estimated the giant could have been 129 feet long and almost five stories high, and weighed 75 tons. The bones of this dinosaur from the Dry Mesa Quarry are also in the Museum of Ancient Life.

BYU made the first film documentary of the progression of the excavation at Dry Mesa Quarry, from the toe bone found by Vivian through the further discoveries. *National Geographic*'s August 1978 issue had an immense article on dinosaurs that included a paragraph about the *Brachiosaurus* and *Supersaurus* found in the Dry Mesa area.

Eddie Jones passed away in 1985. Vivian continues to live in their home in Delta and pursue her lapidary and collecting interests. She made a display board of her dinosaur bone cabochons. They show many colors, agatized marrow cavities, and spider web patterns, and some are translucent. Most bone is jasperized and opaque. Green and gold are the rarest colors in bone. Over the years, Vivian displayed dinosaur bone specimens at the Salt Palace in Salt Lake City, Utah, and at shows in Wickenburg and Sun City, Arizona, and Grand Junction, Colorado, and was awarded many ribbons.

Vivian reminisced about the fun times she and Eddie had when going out hunting for arrowheads, rocks, uranium, and dinosaur bone. They had an extensive bone collection in their home. In 1989, she made the decision to transfer the collection to the Delta County Museum (251 Meeker St., Delta, CO 81416, 970/874-8721). A separate room was made available for the specimens. She has been happy with the decision because the specimens were found near Delta. Now, local residents and visitors from all over the world may view them.

JONES FAMILY PHOTO

Walter Cronkite interviewed Vivian at Dry Mesa Quarry for a television documentary.

Vivian received a call in 1990 from a lady in Ontario, Canada, saying she wanted to do some filming at Dry Mesa Quarry. She arranged for Vivian to be there for an interview. The good news for everyone concerned was that Walter Cronkite would fly to Delta on Labor Day to do the interviews with Jensen, other BYU officials, and Vivian. The interviews took place as planned. Everyone said Cronkite was easy to talk to and very gracious. Upon completion, the film was shown on television.

When Keith and I visited with Vivian for this article, she showed us the film on the Dry Mesa Quarry and the interviews. Jensen told about the toe bone revelation and the progression thereafter. Cronkite asked Vivian how she and Eddie knew they had found dinosaur bone instead of "just a rock." She explained they knew by the cellular structure, similar to the animal or human cells that are visible in a cross section of bone. She told him the different colors of bone most likely were related to the mineral involved during fossilization. Vivian treasures her picture taken with Cronkite.

In addition to seeing the Cronkite film, we were fortunate to view the documentary filmed by BYU about the caravan trip and the history of their excavation at Dry Mesa Quarry.

I spoke with BYU paleontologist Britt concerning this article. He was very helpful, authenticating, correcting or adding information about dinosaurs, etc. found at the quarry. He said BYU does not have videos, films or documentaries about the history of Dry Mesa Quarry for sale.

According to Britt, Dr. Jensen passed away in 1998. Dr. Ken Stadtman became the Earth Science Museum Curator and continued to work the Dry Mesa Quarry until his retirement. The BYU excavation at the quarry continued until 2001, a period of almost 30 years. Britt stated there have been various reports on the number of dinosaur species found at Dry Mesa; he did not authenticate the report of 14 species. He confirmed that a *Mesadactylus* (a pterosaur, or flying reptile), crocodilians, turtles, fishes and mammals were found at the site. He said Dry Mesa was one of the largest and best quarries from the late Jurassic (about 148 million years ago), and about 4,200 bones were collected there.

Dr. Jensen told the Joneses how appreciative the paleontology world was that they had found the upper arm bone, called him about the five vertebrae, and showed him the toe bone that began the Dry Mesa Quarry saga. Britt told me the Joneses had made great contributions to the science of paleontology by sharing their discoveries with Jensen.

It was a privilege to meet a woman with such a pioneer history in mining, rock hunting, and amateur paleontology. For this and much more, we thank you, Vivian.

ROCK & GEM

Make A Crystal Model, Part II

Locate the hexagonal crystal model that we made from paper last month. Now, what can we learn from it?

The paper clips (or toothpicks) represent four of the hexagonal axes. The one that goes from top to bottom of the crystal is called the "c" axis. The other three axes (a1, a2, and a3) are all at right angles to the "c" axis, and are rotated 120 degrees from each other in the same plane. There are three more axes we have not marked that go from the centers of the side angles to the centers of the opposite angles.

Hold your model vertically by the "c" axis and rotate it until you see "+a1" on the face right in front of your eyes. Now rotate it clockwise till you see "-a3" right in front of you. The model shape looks just the same as it did when the "+a1" face was in front. If you continue around through a complete circle, you will see four more of these points, for a total of 6. Crystallographers call this an "axis of six-fold rotational symmetry."

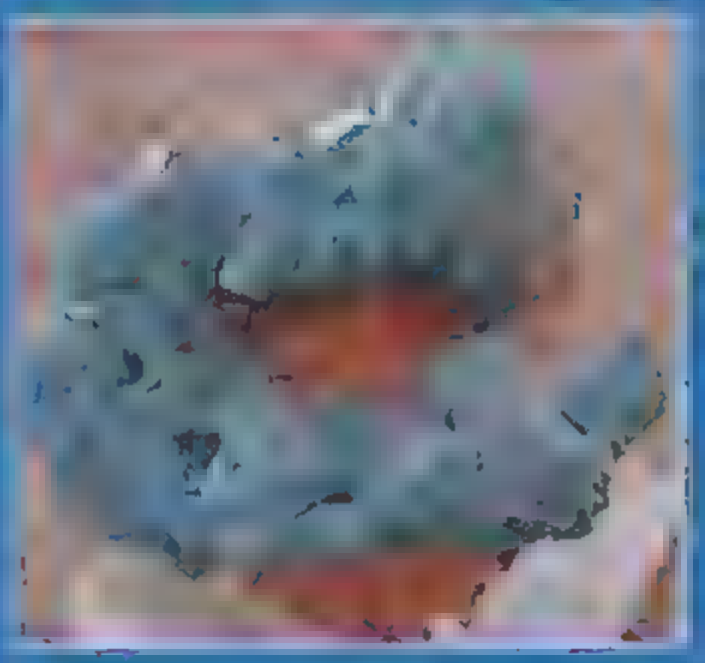
Next, hold the model by the horizontal "a1" axis and rotate it away from you until you see the face marked "+c." Continue to rotate it halfway around until you see the face marked "-c." If you continue to rotate the model on this axis, you will return to the starting place. Since you see the same view twice in each rotation, the "a1" axis has "two-fold rotational symmetry." Hold the model by each of the other "a" axes and check it out! You could even put toothpicks through the other three axes at the corners of your model and see that they also have two-fold rotational symmetry, but it would probably start to look like a pincushion.

Notice that if you look down on your model from the top, the "+" side of each axis is on the left, and the "-" end is on the right. This is a **convention** of Hermann-Mauguin symmetry notation, a type of scientific description of crystal symmetry. It is pretty complex stuff, but Mike and Darcey Howard do a great job of describing it on the Internet at www.rockhounds.com/rockshop/xtal/part6.html. Get your parents' permission to check it out, but don't get discouraged! It takes a lot of study to understand.

KIDS

by Steve Becker

Dioptase



Rock & Gem Kids Quiz

The *Rock & Gem* Kids Quiz contest is open to U.S. residents age 18 and younger. All these questions can be answered by carefully reading this column. Write your answers neatly on a postcard or 4X5 card and mail to *August Rock & Gem* Kids Quiz, P.O. Box 6925, Ventura, CA 93006-9899. Valid entries received by August 31, 2007 will be entered in a drawing from which five winners will be chosen. Valid entries must be the entrant's own work and must include the correct answers, the entrant's name, age and address, and the signature of a parent or guardian. Prizes are generously provided by the Arizona Mineral and Mining Museum Foundation.

1. Dioptase is a _____ mineral.
2. Dioptase belongs to the _____ _____ crystal system.
3. Dioptase does not wear well in jewelry because of its perfect _____.
4. The hexagonal crystal's "c" axis has _____ _____ rotational symmetry.
5. The hexagonal crystal's horizontal "a1" axis has _____ _____ rotational symmetry.

GLOSSARY (Use your dictionary to look up other words you don't know.)

convention a rule or assumption that forms the basis of a system of study

rhombohedron a six-faced solid geometric form similar to a squished cube; each face is a rhombus (diamond shape) instead of a square

The Natural Lapidary

Sculpting Soft Stone Using Stone-Age Techniques

Story and Photos by Storm

Malleable rocks such as talc schist, chlorite schist, serpentinite, and nephrite jade can be worked into pendants.

Soft rocks such as chlorite schist can easily be split using a bone chisel.

Go inside a stone. That would be my way. Let someone else become a dove or gnash with a tiger's tooth. I am happy to be a stone. From the outside the stone is a riddle: no one knows how to answer it. Yet within, it must be cool and quiet, even though a child throws it in a river; the stone sinks, slow, unperturbed, where the fishes come to knock on it and listen. I have seen sparks fly out when two stones are rubbed, so perhaps it is not dark inside at all; perhaps there is a moon shining from somewhere, as though behind a hill—just enough light to make out the strange writings, the star charts on the inner walls.

—Charles Simic,

Dismantling the Silence

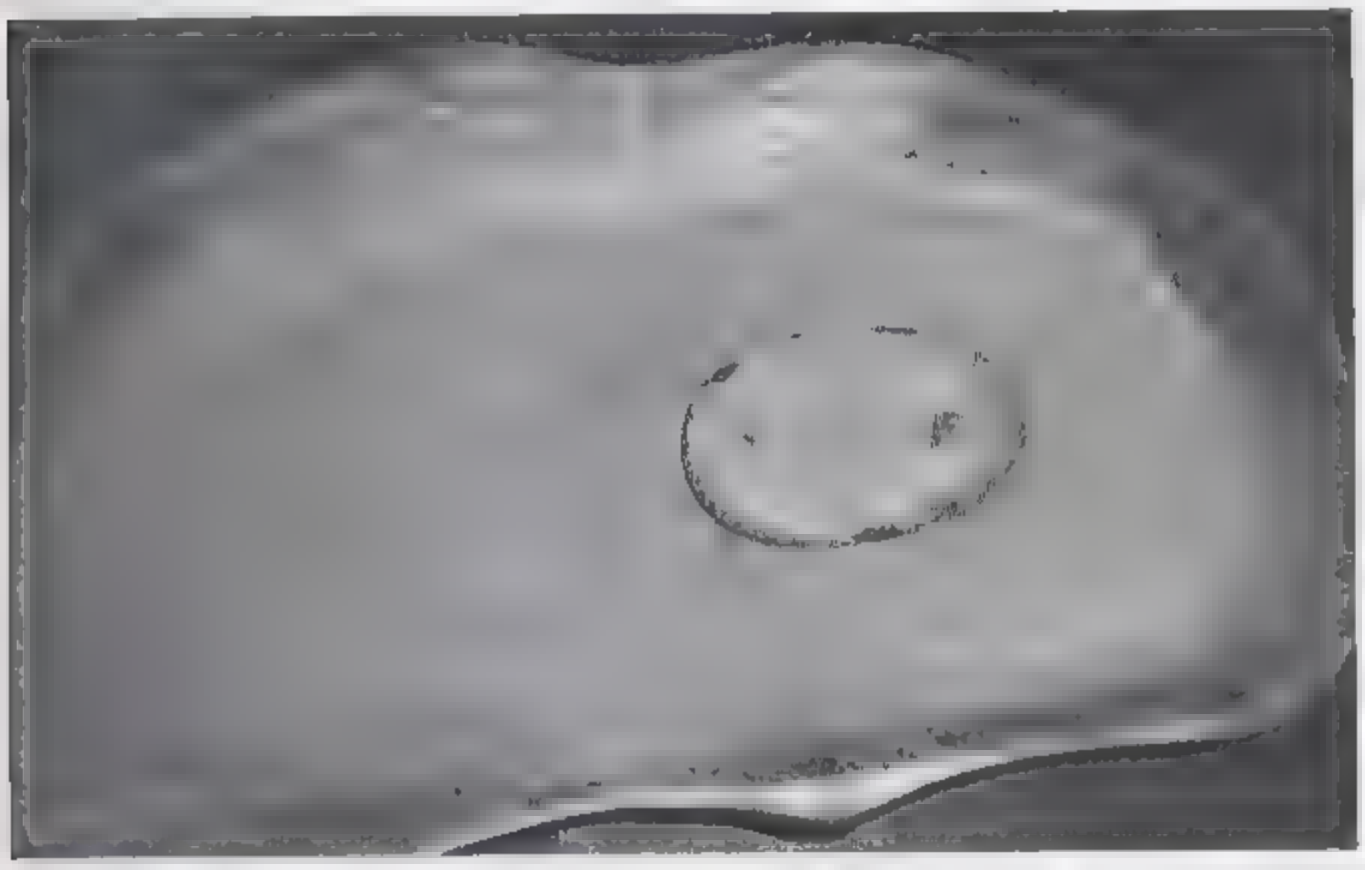
Our relationship with rocks and minerals is quite fascinating. We can depend upon granite and limestone for housing, talc and pumice for beauty aids, clay and chalk for digestive aids, flint and chert for the procurement of fire and meat, and a wide variety of geologic products for entertainment and adornment. Archaeological finds suggest that we have been augmenting ourselves through jewelry for at least 100,000 years, with the advent of material symbolism in the form of *Nassarius* shell beads that have been found in Israel. One of the oldest stone pendants found to date was ground and incised about 26,000 years ago, using Paleolithic technology, during the Gravettian culture in what is now Romania

One of the most satisfying pursuits I've ever engaged in consists of identifying potentially useful natural materials and transforming them into functional tools and attractive works of art. As I walk a beach or hike through the forest, my eyes scour the landscape in search of workable wood, bones and stones. Here in the northeastern corner of the San Gabriel Mountains of Southern California, I am fortunate to encounter an extensive assemblage of attractive crystals (tourmaline, corundum, actinolite, biotite/mu covite/fuschite micas, epidote/zoisite, pyrite, rutile) and malleable rocks such as talc schist, chlorite schist, serpentinite, and nephrite jade.

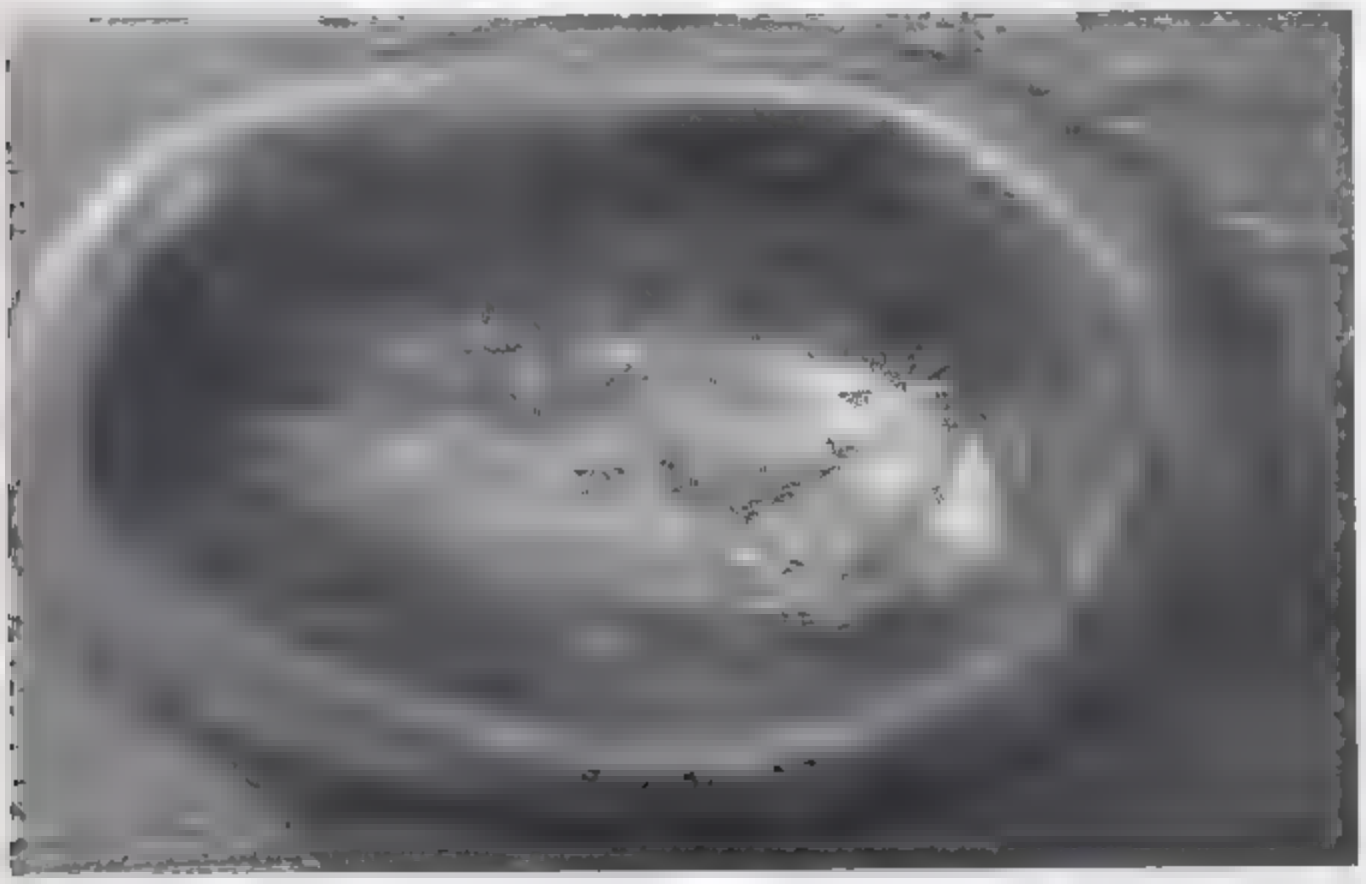
continued on page 55

Coating stone pendants with animal fat or mineral oil reveals their stunning colors and patterns.

It's easy to carve soft stone into decorative items using Paleolithic technology.

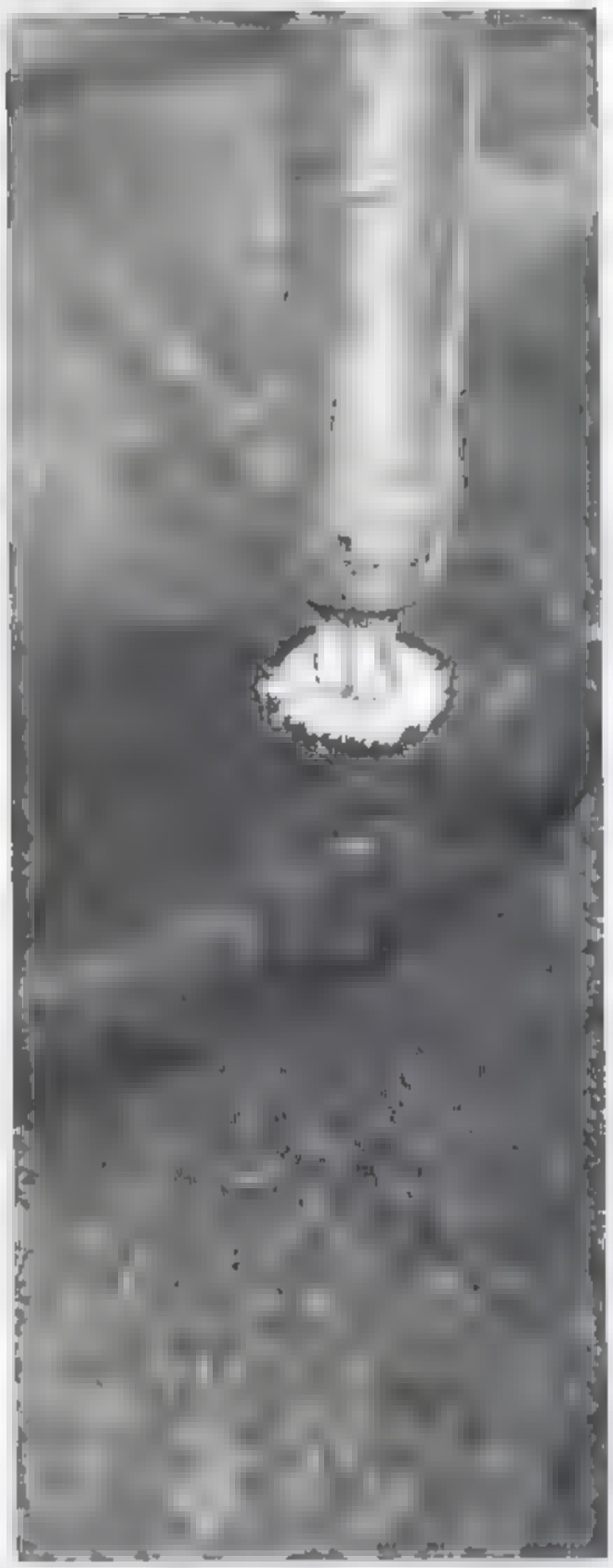


Decomposition of the local gray Pelona schist provides me with adequate polishing grit in the form of fine silt.



I hand-polish soft stone using silt and a piece of buckskin, which can make quite a difference in the finished piece.

The splint bone of a deer easily grooves this rock in preparation for chiseling out unwanted material.



A quartz crystal can be used to drill through a stone pendant in order to attach a natural cord necklace.

If I locate a sizeable boulder of soft rock, such as talc-magnesite schist, I can reduce the material to a manageable size by smashing it with another rock, but I prefer to let nature do as much of the work as possible, so I enjoy finding small cobbles that are ready to be carved and ground into pendants and containers using Stone Age-type tools. The incising tools I use include shards of bone (the needle bones located in the ankles of deer work quite well), beaver and javelina teeth, bird beaks, stone flakes, hafted elk antler saws, and stone knives. Cutting through talc schist, gypsum alabaster, and chlorite is quite easy using these tools, especially if the cutting edges are rough or toothed. Bone needs to be sharpened often, while flint, chert and basalt can score harder rocks without losing their edges.

continued on next page

The Natural Lapidary *from page 55*

When I'm crafting a larger item out of soft rock, such as a bowl, I find it faster to hollow out the interior if I use a bone or antler chisel. After scoring parallel grooves ½ inch apart across the surface of the area to be removed, I insert my chisel into the groove at a roughly 30-degree angle and tap the top of the bone with a stone or wooden hammer. (A layer of buckskin between the top of the chisel and the hammer will prevent chipping.) This removes chunks of rock at a much more efficient rate than grinding can. Careful control of the chisel tip's impact on the margin of the future container must be maintained, or the lip of the bowl might be damaged beyond repair.

Incising isn't always necessary or expedient; if the cobble is small enough, grinding may be all that's required in order to shape the rock into your desired object. I use flat slabs of sandstone or quartzite to grind material that contains minerals softer than quartz. I've ground rocks using both a circular motion and a back-and-forth motion upon the grindstone, and have found that both methods work equally well in maintaining control over the shape of the final product. Please take adequate safety precautions when creating rock dust, which could enter your lungs and cause health problems; most people keep their grindstone wet. I always do my grinding outside to further minimize this concern.

After grinding a rock down to a suitable thickness for a pendant, I usually employ a quartz crystal-tipped hand drill to bore a hole for the necklace. This simple tool consists of a center-pointed quartz crystal that has been sunk and glued into the tip of a straight twig. Usually, the quartz crystals that I've found and used aren't long enough to fully penetrate the pendant stone. A thin, pointed sliver of bone or stone can be used to bore through the rest of the pendant. I like to round off any sharp edges that the quartz drill leaves around the hole to lessen the chance of accidental chipping or breakage.

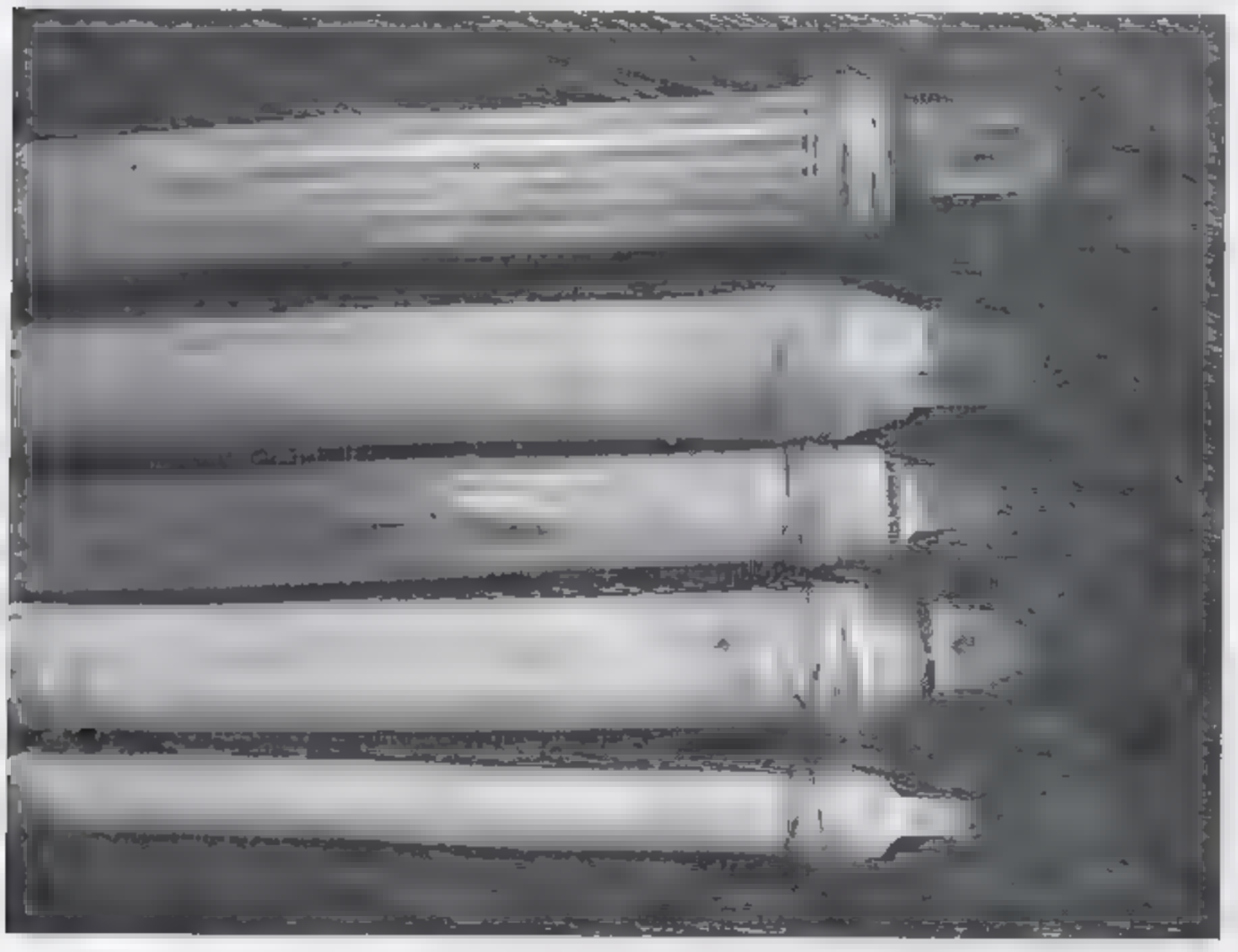
Decomposition of the local basement rock (muscovite schist) provides me with adequate polishing grit in the form of fine silt. I hand-polish stone pendants with this silt using a piece of soft buckskin, which can make quite a difference in the finished piece. The best natural grit I've used thus far is very fine black and white sand that I found in a wash near Barstow, California.

Whether I'm making pendants, containers or fly-wheels for drilling and fire-making devices, I like to coat the finished articles with animal fat. (Mineral oil and beeswax work, as well). Not only does this bring out the stunning colorations and patterns found in rocks, but it might preserve the structural integrity of the product and reduce the visual marring of incidental scratches.

For more information regarding Paleolithic skills and photographs of additional pendants made from stone, please visit my Web site, www.stoneageskills.com.

Natural materials such as bone, stone, antler and teeth make great tools for carving and grinding

Grinding may be all that is needed to shape a cobble into your desired object.



A quartz crystal can be used to drill through a stone pendant in order to attach a natural cordage necklace.

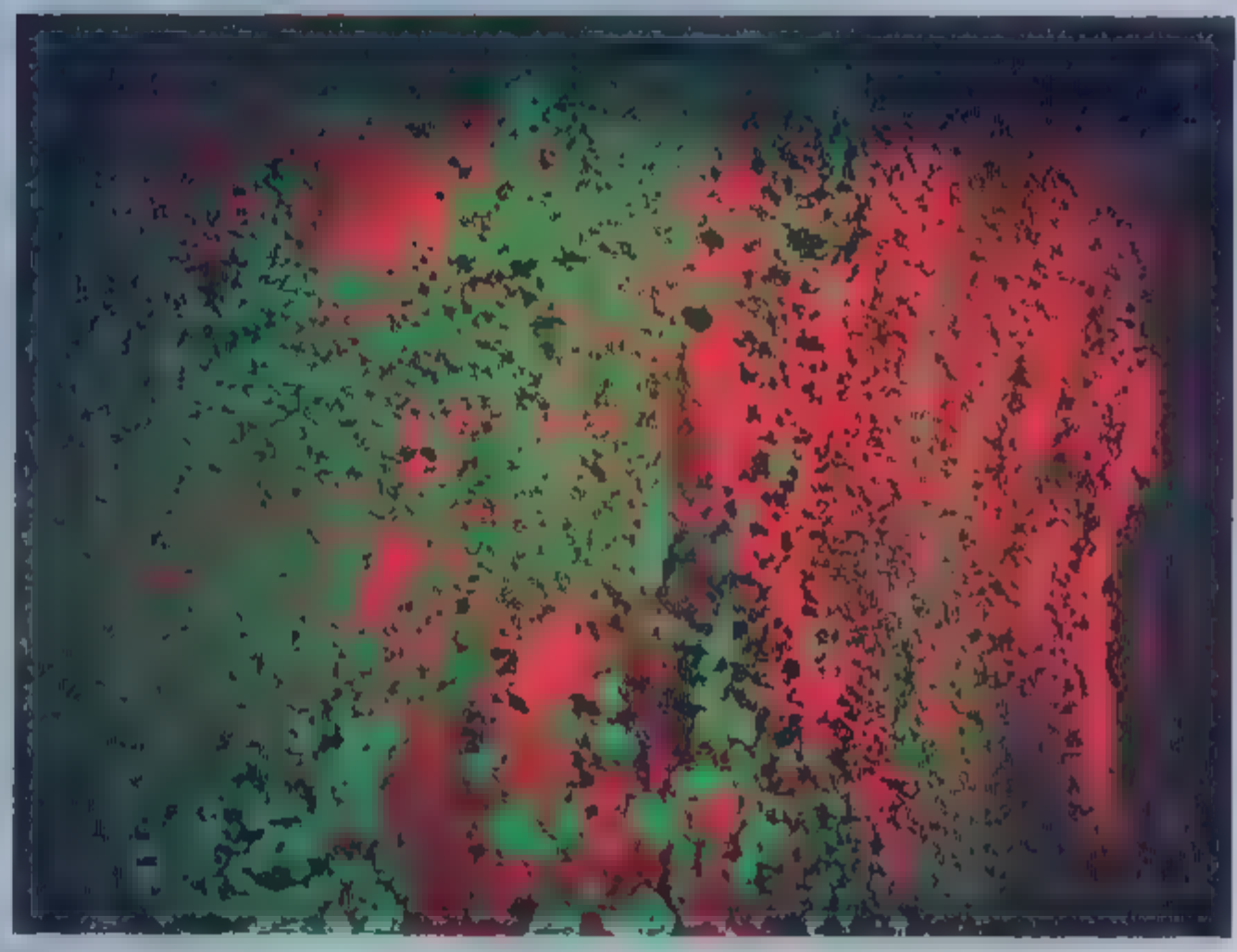
The Franklin and Sterling Hill Zinc Mines

Hundreds of tons of zinc ore once moved through the complex of mine buildings at Sterling Hill.

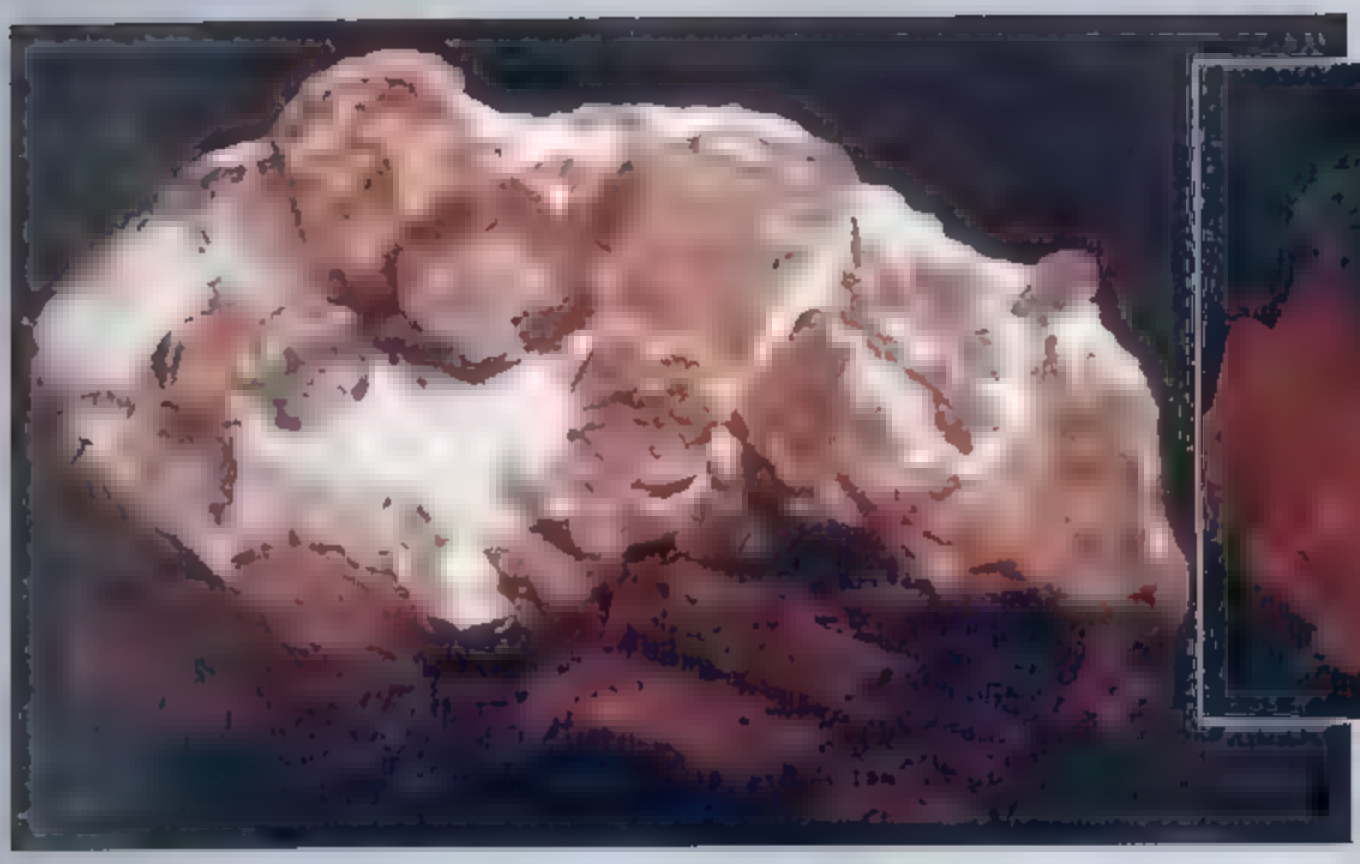
They're Famous for Fluorescents

Story and Photos by Bob Jones

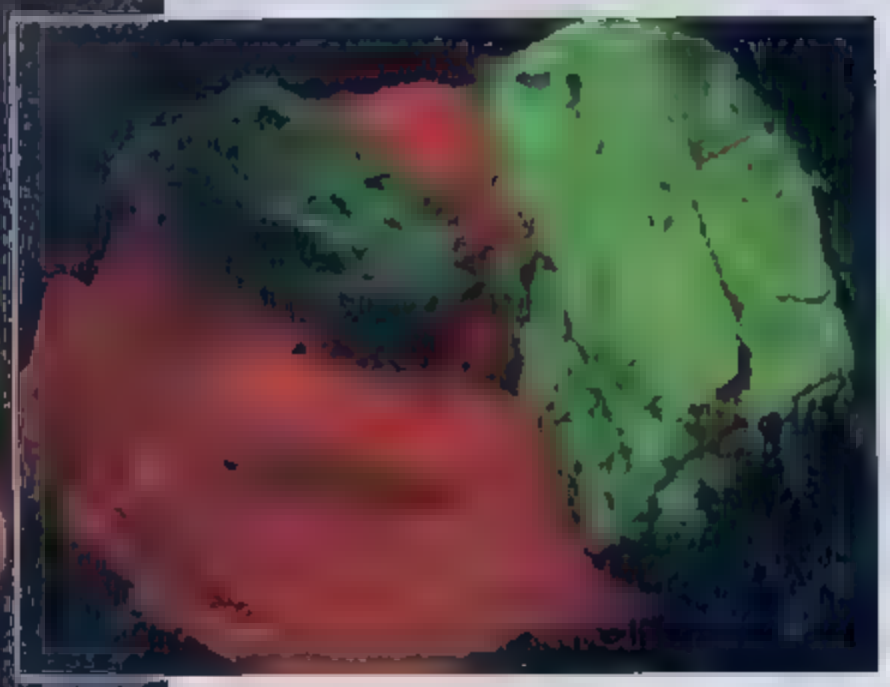
The August 2007 East Coast Gem, Mineral & Fossil Show will feature the history, mining and minerals of the Franklin and Sterling Hill, New Jersey, zinc deposits. And for good reason! From a historical perspective, the deposits have had a profound impact on the production of zinc in this country. From a collector's point of view, they have yielded more new species than any other deposit and a great assortment of minerals, including more than 50 fluorescent mineral species. Also, their close proximity to so many metropolitan areas and universities means they have been accessible to a greater number of scientists and collectors.



The red-fluorescing calcite and green-fluorescing willemite earned Franklin, New Jersey, the title Fluorescent Mineral Capital of the World.



Much of the willemite from Sterling Hill is brick red and is known locally as troostite.



This fine crystal of green-fluorescing willemite rests on a matrix of red-fluorescing calcite from Franklin, New Jersey.

The town of Franklin, New Jersey, is world famous for crystals of the iron zinc silicate franklinite, seen here with equally important willemite.

The Sterling Hill Mining Museum displays a vast array of mining equipment such as this huge jaw crusher, once used in Canada's silver mines.

The Franklin/Sterling Hill area began producing metals as early as the 1740s. In spite of its rich deposits of zinc, the metal-producing region was first known for iron mining. In fact, the Borough of Franklin was known early on as Franklin Furnace, a reference to its iron-smelting facilities. The region is rich in small deposits of magnetite and hematite, which were worked diligently in Colonial days

Both the Franklin and Sterling Hill deposits were obvious to anyone who passed by. The complex, banded rock outcrops were obviously metal rich and instantly drew the attention of people in the region. The local marble outcrops and lenses of iron minerals were easily accessible. Zinc was, at times, simply a byproduct of iron mining. At other times, it was something of an annoyance to the metalsmiths who worked the iron deposits. One mineral in particular, an iron, manganese zinc species later named franklinite, was assumed to be a major iron mineral, but its zinc content really gummed up the smelting works.

Franklinite is a major ore in both deposits. It looks like an iron mineral, is black like an iron mineral, and forms in octahedrons like magnetite, a popular iron mineral. Yet, when introduced into a smelter, franklinite would not behave like magnetite. Its zinc component could not be smelted as easily as its iron content

The real story of the area is the development of the zinc deposits, which proved immensely important to the development of industry while playing a major role in the growth and development of the science of mineralogy. Professors from some of the East Coast's major universities devoted their efforts to the study of these unique depos ts.

continued on next page

Hill Zinc Mines *from page 61*

Between them, Franklin and Sterling Hill, which are just a couple of miles apart, have produced huge tonnages of zinc. The process of mining unearthed more than 300 different mineral species. Among the common ore species, the major ores are willemite, franklinite and zincite. Because of the extreme complexity of the ores, which contain dozens of trace elements, Peter Dunn, a researcher for the Smithsonian Institution's Department of Mineral Sciences, is the author of a series of books called *Franklin and Sterling Hill New Jersey: The World's Most Magnificent Mineral Deposits* (self-published,

A fine display of gold is an eye catcher in the Sterling Hill Mining Museum.

1995). Dunn reports that nearly 70 new mineral species have been identified at Franklin/Sterling Hill, some of them unique to these deposits. His four-part series is available from the Franklin-Ogdensburg Mineralogical Society, P.O. Box 146, Franklin, NJ 07416 or http://franklin-sterlinghill.com/dunn/copyrights.stm.

New Jersey franklinite is most often found associated with willemite, a zinc silicate. Lesser amounts of zincite, a red zinc oxide are also found, along with a host of zinc, manganese and iron-bearing minerals, some of them so complex that their chemical formulae look like a listing of the Periodic Table of Elements. Manganpyrosmalite is a good example; it is a manganese, iron silicate that can contain traces of aluminum, calcium, lead, titanium, barium, boron, copper beryllium, silver, strontium, nickel, etc. Turn that many elements loose in a hydrothermal solution, and Mother Nature can have a field day creating new species.

Even willemite can be a catch-all of elements in minor and trace amounts. Aside from the zinc, oxygen and silicon that go into its makeup, Dunn lists 16 other chemical elements that can be found as trace elements in Franklin and Sterling Hill willemite.

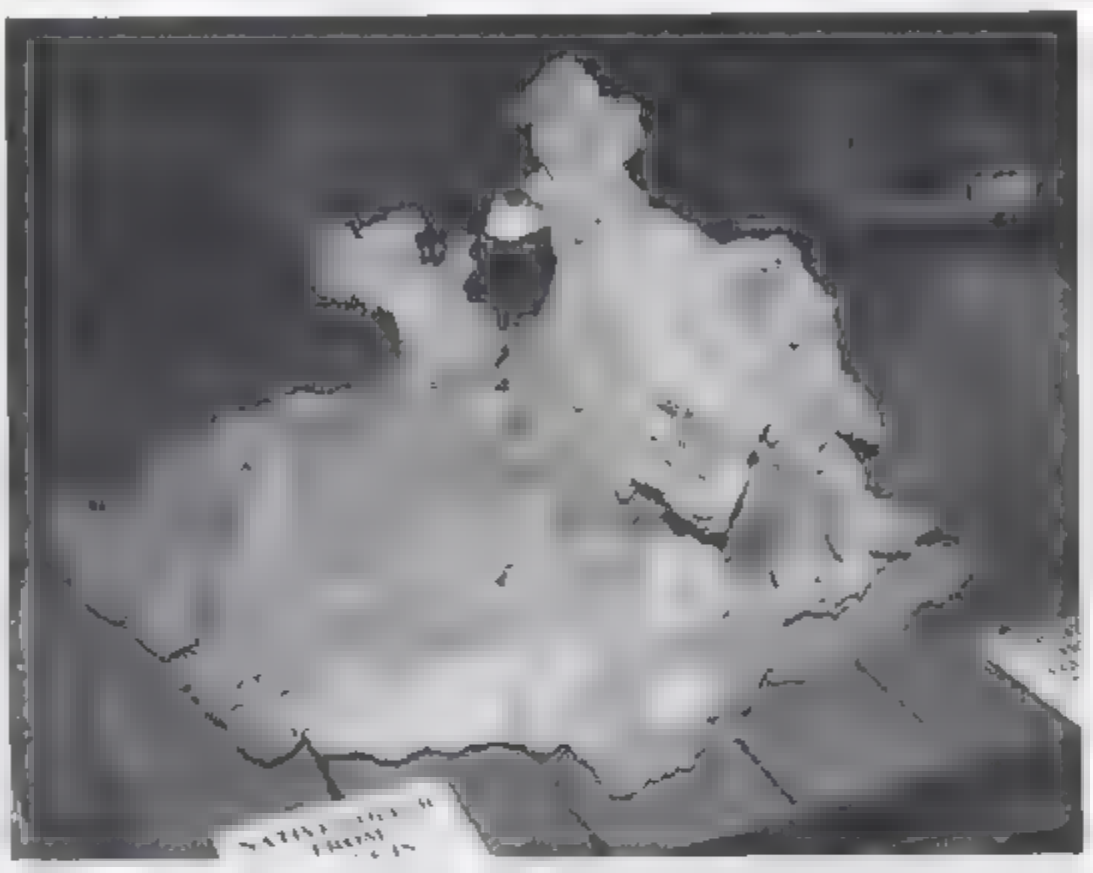
As scientists studied the ores of Franklin/Sterling Hill, they realized they had a unique deposit on their hands. This led to all sorts of theories on the origin of these companion deposits through the years. In Part I of his series, Dunn does a wonderful job of describing these various theories before presenting the latest information on just how such complex ores evolved. The story is not yet complete, but evidence is mounting that the deposits, which undoubtedly reach back billions of years, started out in an oceanic environment. Whether the metals were initially deposited by something akin to a black smoker—as I prefer to think—or as a series of sediments deposited in a warm ocean environment is still not understood. There is no doubt, though, that once the initial deposition occurred, extensive and repeated metamorphism and hydrothermal action resulted in two amazing and complex ore bodies rich in zinc, iron and manganese. Those fascinated by these deposits and interested in a very detailed and comprehension discussion of both Franklin and Sterling Hill are recommended to obtain Dunn's series of books.

Because of the complexity of these ores, university professors and researchers made repeated visits to collect samples for study. The best known study from the days just before and after World War II was the one Charles Palache conducted in 1935. "The Minerals of Franklin and Sterling Hill, Sussex County, New Jersey, Professional paper #180" was so useful and popular that it was reprinted in 1937, 1961 and 1974. These latter editions were produced by local organizations.

Mineral collectors of the 1930s descended on Franklin and Sterling Hill, contacted miners who might have specimens, and scoured the dumps of various mines, particularly in the Franklin area. Some of those dumps are still there, though they are considerably reduced in volume and production of good specimens.

When I was collecting and studying Franklin material in the 1950s, Sterling Hill was pretty much off limits, but there were sites in Franklin worth visiting, such as the Franklin dump. The Palmer dump was closed at that time, but it has since become private property and the owner allows collecting during special events. The Parker dump was wide open and particularly fascinating, but a fire station and public park were built on it in 1962. The Franklin dump, located behind the Franklin Mineral Museum, is still accessible through the museum for a small fee.

There are two museums in the area, the Franklin Mineral Museum and the Sterling Hill Mine and Museum. Each has done a superb job of preserving the history of the area and assembling excellent specimen displays. The minerals are extremely varied, dominated by the three major ore species: franklinite, willemite and zincite.



Among the Sterling Hill Museum's world mineral specimens is float copper from Michigan's Upper Peninsula

Franklinite occurs as massive black material, as small, tightly packed spherical grains, and as discrete crystals almost always embedded in white to pale tan calcite or massive white to gray willemite. Discrete crystals of franklinite are not easy to obtain. They are often enclosed in calcite, which may be partially embedded in the franklinite crystals, so it is difficult to separate the two without damaging the black octahedrons. In fact, sharp, undamaged franklinite crystals are not common, especially crystals measuring several inches on an edge. Efforts have been made to return damaged franklinite crystals to pristine condition by repairing them with plaster of Paris or some such, then painting them black. Some of these "repairs" are artfully done and hard to detect, but careful examination usually reveals the deception.

Franklinite crystals can be quite large, to 4 inches on an edge, but are almost always much smaller. The smaller crystals are more perfect and sharper; larger crystals tend to be rounded on the edges and are often incomplete. Sometimes, crystals are intergrown, but most occur as single prisms with massive minerals like calcite, willemite, zincite and rhodonite.

Willemite is a delightful Franklin/Sterling Hill mineral. The Sterling Hill willemites are often called troostite because they are usually brick red, thanks to a fairly high iron content. The Sterling Hill troostites are often rounded and opaque, but can be quite large, to 2 inches long. Their form is almost always blocky, and they frequently have calcite embedded in them, so they are often incomplete. Franklin willemite, on the other hand, ranges from colorless to pale yellow to green. Small prisms are often gemmy, but these are not at all common. Willemite is more often massive, in large, usually rounded forms embedded in calcite. Sometimes, the local gneissic rocks are intergrown with franklinite. Franklinite and willemite seem to be quite constant companions. Masses of solid willemite were frequently encountered during mining

The property of willemite that most collectors find fascinating is its fluorescent response. Under shortwave UV light, willemite will often fluoresce bright green, so bright it sometimes borders on white. This property is so useful that mining companies hung UV lights over a rotating "picking table," where an operator would sort ore according to its fluorescent response.

UV lights are a study unto themselves. The earliest devices were called iron spark machines. An electric current was passed across a gap between two electrodes, producing copious amounts of light as well as UV radiation, which would cause a response in some minerals. An iron spark machine was used in one of the earliest studies of fluorescence conducted on the New York Museum of Natural History's collection of minerals. Unfortunately, the excessive amount of ordinary light the spark also produced obscured or dimmed the UV response.

continued on next page

The Franklin and Sterling Hill Zinc Mines *from page 63*

The iron spark source of UV light was finally replaced by the mercury vapor tube, which is still in use today. The tube is made of pure quartz glass that will allow UV radiation to pass; ordinary glass does not. Inside the sealed tube is a bit of mercury. When excited with an electric current, the mercury vaporizes and gives off shortwave UV radiation and a lot of visible light. The visible light is then filtered out using a piece of blue-violet cobalt glass, and the radiation given off causes some minerals to glow.

Coupled with a small, portable battery, this small source of shortwave and/or longwave radiation can be carried into the field to seek out deposits of fluorescent minerals. Amateur collectors spent countless hours scouring mine dumps and outcrops, especially around Franklin, where collecting was very fruitful. The quantity of fluorescent material the Franklin dump once held is truly amazing. Through the decades, tens of thousands of collectors have carried away a huge quantity of fluorescent rock

The bulk of what was collected was a very common mixture of red-fluorescing calcite and green-fluorescing willemite. Since this colorful mix was so common and easily collected when the Franklin dump was wide open, people would use it for trade all the way across the country! Before long, every shop boasted a nice selection. In my nearly three dozen trips across the country, I'll bet I've seen more Franklin fluorescent material than any other type of mineral species.

While both franklinite and willemite can occur in crystal form, zincite, the zinc oxide, simply does not. The known sharp prisms of zincite from Franklin/Sterling Hill, which now reside in museums, can be counted on one hand! Zincite, like franklinite, does not fluoresce. There is the odd exception, but in general the pure zincite from this part of New Jersey does not respond under the lamp. It does, however, occur as brick red to orange-red masses and streaks in calcite. In some cases, the zincite will actually exhibit rather rounded, distorted prism shapes totally enclosed in calcite. These tend to be incomplete crys-

tals, and it is useless to try and extract them. Some of the calcite, willemite, zincite and franklinite material lends itself to cutting and polishing. The random arrangement of the various colors—red, greenish, white, gray and even black—makes very attractive cabochons and spheres.

In any conversation about Franklin/Sterling Hill minerals, the subject of fluorescence will inevitably crop up. After all, these deposits have produced more than 50 responsive minerals, more than any other source. All shades of every color of the rainbow are represented in some mineral from either Sterling Hill or Franklin. I expect there is not a single fluorescent mineral display anywhere that does not have one or more brightly fluorescent specimens from these deposits.

Dick and Bob Hauck were able to realize their dream of saving the Sterling Hill Mine from oblivion.

Naturally, the serious fluorescent mineral collector will endeavor to add as many of Franklin's exotic minerals to his collection as possible. The Franklin ore body was very likely to yield unusual fluorescent species like clinohedrite, esperite and hardystonite. Sterling Hill, on the other hand, is not known as a prolific source of rare species that fluoresce.

The Parker Mine was best known for the really exotic species. Many came from mining in the Parker deposit itself, though some of the rare species that found their way to the surface through the Parker Shaft were found elsewhere in the mine. The Parker Mine yielded a dozen or so rare and unique species, a few of which respond to UV excitation. Two, clinohedrite and margarosanite, which is so rare, are highly prized by UV collectors today. Esperite was also found in quantity in the Parker Mine, and less commonly in the Franklin Mine.

The Parker dump was a particularly exciting place to spend a dark night. The dump was not large, a few dozen feet in each direction. One interesting boulder on the dump was a huge mass of limestone with small, fluorescent blebs of chondrodite not associated with ore body material. That boulder took quite a beating through the years!

On the Parker dump, collectors sought specimens that contained esperite (formerly called calcium larsenite) and hardystonite, margarosanite and clinohedrite. The prize of a night's search would be a specimen boasting three species: esperite, which fluoresced yellow; hardystonite, which fluoresced a soft blue-violet; and orange-fluorescing clinohedrite.

Clinohedrite and margarosanite were first encountered when a couple of raises were started in the Parker Mine in 1895. Also found were several other minerals unique to the zone in question, including roeblingite, hancockite and nasonite. What set this section of the ore body aside from others was that the area had been recrystallized, an action that changed existing species and created new ones. Luckily, a portion of this particular exotic zone, known as the lead silicate zone, was left as a support pillar during early mining. When the mine was on the verge of shutting down in the 1950s, this remaining support pillar was mined out, producing a surge in these rare species, which are still on the market. Once in a while, a private collector will release a specimen of one or more of these rarities. Such specimens are immediately pounced on by fluorescent mineral aficionados.

Franklin/Sterling Hill fluorescent minerals have become so popular that plenty of collectors collect them exclusively. A number of books that treat the subject of fluorescent minerals, usually with emphasis on Franklin/Sterling Hill fluorescent minerals, are now available. Museums always have exam-

ples of Franklin/Sterling Hill fluorescent minerals on display with other species of note.

One of the more attractive nonfluorescing Franklin/Sterling Hill species is rhodonite, a calcium manganese silicate. It occurs as pink to reddish crystals and as massive material. The blocky pink crystals, often perfectly terminated and embedded in calcite are most attractive. The contrast between the white calcite and the intensely pink rhodonite makes very attractive collector specimens

It should be noted here that the Franklin/Sterling Hill ores were not very vuggy. Few openings of generous size existed in the deposit, so large quantities of discrete crystals never did occur here. Most crystals have to be dug out of the enclosing calcite, which naturally restricted their crystal growth, and are usually damaged by the exposure effort.

A second form of rhodonite, often called fowlerite locally, formed in small openings in the deposit as thin-bladed crystals in tight clusters. Its blades are usually light pink and form in tight subparallel groupings covering matrix. The name fowlerite recognizes Samuel Fowler, a major player in the development of the Franklin deposits and applies to the form of rhodonite that is thin-bladed and a lighter pink due to included calcium in the structure.

I doubt there is another area in the eastern United States that is host to more collectors than that which encompasses the Franklin Museum and dump and the Sterling Hill Mine and Museum. The Franklin Museum and mine dump tend to attract mainly collectors who are interested in seeing what came from these ore deposits and digging in the Franklin dump. Museum folks even maintain a small darkroom on the dump so you don't have to crawl around under a blanket as we did back in the 1950s. The dump has now been worked so much that the collector who finds something really exceptional today is lucky

When I worked the Franklin dump back in the 1950s, pickings were very good. You tossed aside the calcite/willemite pieces, most of which were more calcite than willemite, in hopes of finding something a lot more exotic like aragonite and blue-fluorescing hydrozincite. I never found any esperite there, but apparently some folks did. If all you wanted was the red-fluorescing calcite and green-fluorescing willemite, you could simply fill the trunk of your car Many did, and the dump has suffered as a result.

Sterling Hill is another matter. The mine operated much longer than Franklin's, which shut in 1954. When the Sterling Hill Mine closed in 1986, the mining company chose to auction off the property, which was bought by Bob and Richard Hauck. I consider this nothing short of a miracle, as it saved the property, its historically important buildings, and even the underground workings from a terrible fate.

continued on next page

This sign greets visitors to the Sterling Hill Mine and Museum.

Bob and Dick were able to realize their goal of preserving the property and buildings, eventually opening a mine tour and developing a museum. It took thousands of hours of work by many dozens of volunteers to make the Haucks' dream a reality. Most of the volunteers were ex-miners who simply wanted to see the place preserved. One of the first things the Haucks did was apply for National Historic Site recognition. Today, the Sterling Hill project is run by a governing board. The Haucks have remained the major staff

As soon as the New Jersey Zinc Co. decided to shut the mine, it pulled the pumps that were dewatering the underground works and the waters began to rise. I was lucky to get underground at Sterling Hill before the water level prevented access to the deep workings. Dick and I climbed down steel ladders to the 2,500-foot level and enjoyed collecting some beautifully fluorescent crystallized willemite-calcite pieces It was fun until the time came to leave. That required climbing those same ladders to the surface. a real challenge!

While access to deeper areas of the mine was still possible, John Kolic, a former Sterling Hill miner, was given the task of going underground and searching for exceptional species and anything else that caught his eye. He was well schooled in the rare species of the ore body and brought out some new mineral species, including kolicite and hauckite!

The highlight of a visit to Sterling Hill is the guided mine tour, which is really well done. More than 25,000 people a year, many of them schoolchildren, tour the mine. The tour explains the mining methods used there. Highlighted by equipment demonstrations and exhibits throughout the tunnel experience, the tour is beautifully capped with a visit to the underground Rainbow Room.

State regulations required more than one exit from the underground mine tour, so a tunnel had to be drifted from inside the mine to exit not far from the old Noble and Passaic pit sites, two very important pits in the early days of Sterling Hill mining. This made the tour an easily walked loop trail. Since the mine is regularly inspected by state officials, the tour is completely safe.

In drifting the new tunnel, miners suspected they might encounter remnants of the ore body, and indeed they did. To everyone's amazement, a section of the ore body was blasted open and a wall of willemite and calcite was exposed. The two minerals were banded together to form alternating stripes of red-fluorescing calcite and green-fluorescing willemite that were arched like a rainbow. The wall was incorporated into the tour as the Rainbow Room. Visitors really get a thrill when the regular lights are turned off and the UV lights come on, exciting the far wall into a brilliant, arching band of red and green

Dick Hauck explains the Sterling Hill Mine's underground operations to East Coast Show promoter Marty Zinn and Franklin and Levina Ellise, who donated the museum's planetarium.

There are several sections to the Sterling Hill Museum. The main hall is in a large room that the miners called the change room. The change room evolved during the early days of gold mining in this country and was designed to prevent the highgrading of valuable ore samples. Miners would smuggle gold and silver ore and specimens out in a pants pocket, up a sleeve, or in a pant leg that was tied at the bottom, so the mining companies began requiring miners to change their clothing before going off shift. Highgrading was not a serious problem at Franklin and Sterling Hill, though fine specimens often went home in a miner's lunch pail. These specimens were eagerly scooped up by visiting collectors.

At Sterling Hill, the change room had a different purpose. Working in the wet, filthy, and quite cold underground environment required special clothing that could be removed and hung to dry when men went off shift. Though the room has been converted into a museum exhibit hall, you can still look up and see an array of miners' work clothes hanging there.

The change room holds the main mineral exhibits. There is an exceptionally beautiful open vault containing large, crystallized gold specimens from California. One display case is chock-full of masses of native silver from Cobalt, Ontario. Other display cases hold miners' lamps and mine memorabilia from pictures to empty dynamite crates. There are also exceptional displays of superb Franklin and Sterling Hill mineral species in which most of the 300-plus known species from this area are represented. Another section of display cases holds wonderfully attractive species of minerals from all over the world

Once you leave the change room, you enter the mysterious world of fluorescent minerals. Seeing fluorescent minerals at their best requires virtually no ambient light, so the Tom Warren Fluorescent Museum is underground. The room is softly lit and each display case has its own strong fluorescent lamps to bring out the best in the minerals displayed. My favorite display holds cut and polished pieces of Sterling Hill and Franklin ores that simply come alive under UV light. You'll see the usual red- and green-fluorescing minerals in abundance, but you will also get to see many of the rarities of these deposits, which you are not likely to see even in private collections.

Luckily, you will be able to see some of these rarities and a host of the best from Franklin and Sterling Hill if you attend the East Coast Gem, Mineral & Fossil Show in West Springfield Aug 10-12, 2007. There is free parking, and you will enjoy 50 display cases holding wonderful examples of fine minerals from Franklin and Sterling Hill. These deposits wrote an important chapter in the history of mining in America.

Rock Science

by Steve Voynick

Chromite, Crocoite ... and Chromium

At first glance, chromite and crocoite appear to have little in common. The dull, blackish-brown, massive form of chromite, an abundant mineral, interests few collectors. Rare crocoite, on the other hand, with its bright orange-red, needlelike prisms, is among the most eye-catching of all mineral collectibles. Nevertheless, these minerals do have something in common: Both contain chromium and, at different times, both have served as chromium ores.

When German mineralogist and geologist Johann Lehmann discovered crocoite in the Berezovski gold-mining district of Russia's Ural Mountains in 1761, he named it "Siberian red lead." The mineral's true nature remained a mystery until 1797, when French chemist Louis-Nicholas Vauquelin treated it with acid to produce a strange oxide. He then reduced this oxide in a charcoal oven to yield a previously undiscovered element: a lustrous, hard, steel-gray metal with a high melting point and a density like iron's.

Vauquelin named his new element chromium, after the Greek word *chrōma*, meaning "color," a reference to the bright colors of many of its compounds. Vauquelin also determined that "Siberian red lead" was actually lead chromate ($PbCrO_4$), the mineral we now know as crocoite.

During the early 1800s, the limited supply of crocoite coming from Russia and, to a lesser extent, from Germany had one important commercial use. When finely ground, it produced "chrome yellow," a brilliant yellow powder that made a superb paint pigment and dye base. Crocoite was also the only source of chromium, a metal that, while metallurgically interesting, still had no uses at that time.

Crocoite was completely forgotten after 1850 when mineralogists identified large deposits of chromite, an iron (ferrous) chromic oxide ($FeCr_2O_4$). As chromite mining provided larger quantities of chromium, chemists began synthesizing chrome yellow for pigments and dyes, while metallurgists attempted to find uses for metallic chromium.

Crocoite made the news again in the 1890s, when Australian silver miners on the island of Tasmania encountered pockets that were filled with the largest and most well-developed crocoite crystals ever seen. Mineralogists were astounded by the quality of the beautiful Tasmanian crystals, and crocoite specimens soon became hot items on the world collector markets.

Most Tasmanian crocoite specimens met another end. Due to crocoite's rarity and to the growing scale of chromite mining, crocoite no longer had value as a chromium ore. It did, however, make an excellent smelter flux; its chromium component combined with silver-lead impurities to form an easily separable slag. Hence, countless specimens of this rare, beautiful, and eminently collectible mineral unfortunately ended up in the smelting furnaces.

Meanwhile, metallurgists had discovered that mixing metallic chromium with steel produces alloys that are very resistant to oxidation because the surface chromium atoms oxidize to form an inert layer of iron chromic oxide ($FeCr_2O_4$, or synthetic chromite) that protects the underlying steel. Only a few atoms thick, this transparent layer allows the characteristic, bright gleam of the underlying, unoxidized steel to shine through.

Chromium is also superbly suited for electrolytic plating. Plated chrome is hard and durable and takes a mirrorlike polish, making it ideal for many products, including toasters, metal furniture, and automotive trim.

More than 17 million tons of chromite ore are now mined worldwide each year, mostly in South Africa and Kazakhstan. Ninety percent of all chromium is used in electroplating or to manufacture stainless steel. The current price of refined chromium metal is about $5 per pound. Refined chromite is a component of refractory brick and thermally resistant ceramics; chromium compounds are used to manufacture pigments, catalysts, and chemicals. The United States, which uses more than 10 percent of the world chromium supply, has no chromite mines at all.

And what of crocoite? Well, it's still mined in Tasmania, but unlike chromite, only in small quantities as specimens. Nevertheless, it's good to remember that today's booming chromite-mining and chromium-manufacturing industries got their start with crocoite.

FIELD TRIP

Phoenixville Dolomite Crystals

A Unique Collecting Site Near Philadelphia

Excellent orange to light tan crystals can be found on the surfaces of many of the rocks that line the northeast side of the railroad.

Story and Photos by Robert Beard

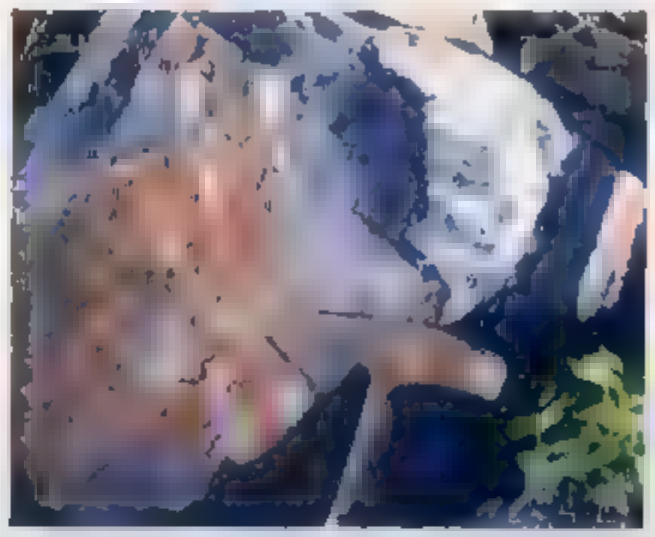
The area around Philadelphia has some interesting and classic mineral collecting localities, but as in most urban and suburban areas, many of the collecting sites are on inaccessible private land or have been destroyed through development. This may make it seem difficult to find good sites in this area. However, these same developments and construction projects have indirectly resulted in some very productive collecting sites.

The best areas are often in crystalline, metamorphic and carbonate rocks, as opposed to shales, sands, and unconsolidated sediments. When uncovered, the rocks will often have collectible minerals. The area west of Philadelphia has many such areas, and it is important to look not just at the exposures, but also at the rocks that have been excavated and used as berms, riprap, or other barriers.

A few years ago, while at the Central Pennsylvania Rock & Mineral Show in Harrisburg, Pennsylvania, I stopped at the stand of Caldron Crafts of Catonsville, Maryland. Caldron was one of the few dealers that had books, and I tend to buy far more books at shows than anything else. I was browsing the 2000 edition of *Gem*

A rock hammer is useful for trimming the pieces of dolomite to a manageable size for transportation back home.

The orange crystals stand out well against the gray dolomite host rock.



Crystal-covered surfaces are easy to find at this site.

Trails of Pennsylvania and New Jersey by Karenne Snow and Scott Stepanski (Gem Guides Book Co.). I have the 1996 edition and have visited several sites in the book, and it is a very good guide. The 2000 version was nearly the same, but it had a new listing that immediately caught my attention.

The entry was "Phoenixville Dolomite," and it described a site with dolomite crystals on excavated boulders adjacent to Columbia Station along a rail line near Phoenixville. From a minerals standpoint, the Phoenixville area is perhaps best known for the pyromorphite locality on the golf course of the Pickering Valley Golf Club, and this dolomite crystal site was something I had not heard about.

Since I live in Harrisburg and travel to Philadelphia on a regular basis, I thought this would be a good site to check out. It would mean buying a new version of *Gem Trails* that only had one additional site, but if it turned into a good site, the price of the new book was negligible. I spend far more on gasoline to go mineral collecting, and having sound trip directions can make all the difference between success and utter failure.

Dolomite, $CaMg(CO_3)_2$, is a common rock-forming mineral. It is commonly found associated with limestone, $CaCO_3$, which is mainly calcite and aragonite. If a rock has a high percentage of dolomite, it is often referred to as dolomite or dolostone instead of limestone. However, it is often hard to know for sure in the field, so the term dolomitic limestone is often used.

Geologists use acid to tell dolomites and limestones apart in the field. If the rock effervesces (fizzes) easily under dilute hydrochloric acid, it is generally considered limestone. If it has to be scratched before it fizzes, it is considered dolomite. Dolomite is harder and denser than calcite, and this makes it good aggregate for concrete and roads. It has also been used as a source of magnesium in the refractory and chemical industries.

Although dolomite is found extensively in old rocks, there are almost no locations where dolomite is being formed today. This is referred to as the "dolomite problem." Although it is difficult to prove, rocks that become dolomite have apparently undergone a dramatic mineralogical change. The calcite deposited in limestone is converted to dolomite through interaction with magnesium-rich groundwater with a high salinity. This would be most likely found in warm, tropical environments near oceans, and although such environments are common, it is not possible to find dolomite forming currently in these environments.

Dolomite crystals often have a curved shape that makes them resemble a small sickle or saddle. However, sometimes they are not curved and simply form small rhombohedrons. Dolomite is a good example of a mineral that familiarity with mineral associations will help you identify. If you are finding crystals in a carbonate environment that resemble dolomite, they are likely dolomite. Conversely, if you find crystals that resemble dolomite in pegmatites or crystalline rocks and they appear to be primary minerals that formed at the same time as the host rock, they are likely some other mineral.

Dolomite is common in hydrothermal veins in metallic mineral deposits, and it is a typical gangue mineral associated with galena and sphalerite. Gangue minerals are the economically valueless minerals in an ore that are mined and later separated out. Other common gangue minerals include quartz, calcite and fluorite.

Another interesting aspect of the Phoenixville dolomite crystal locality is that the dolomite crystals might actually be the iron-bearing variety of dolomite known as ankerite, $CaFe(CO_3)_2$. Ankerite is similar to dolomite except that it is yellowish brown to brown instead of white to gray, and it is common in iron-bearing formations.

continued on next page

Phoenixville Dolomite Crystals *from page 81*

Despite the nearness of the site to my home in Harrisburg, I did not visit it until August 2006. I had a free weekend, as my wife and kids were out of town. Collecting with your family can be a challenge, especially when visiting unknown sites. If the trip is a bust, everyone is mad at you. Actually, even if the trip is successful, everyone is still often mad at you. Summertime collecting, especially if it's not in a quarry, can also be tough in the Northeast, as vegetation is at its thickest.

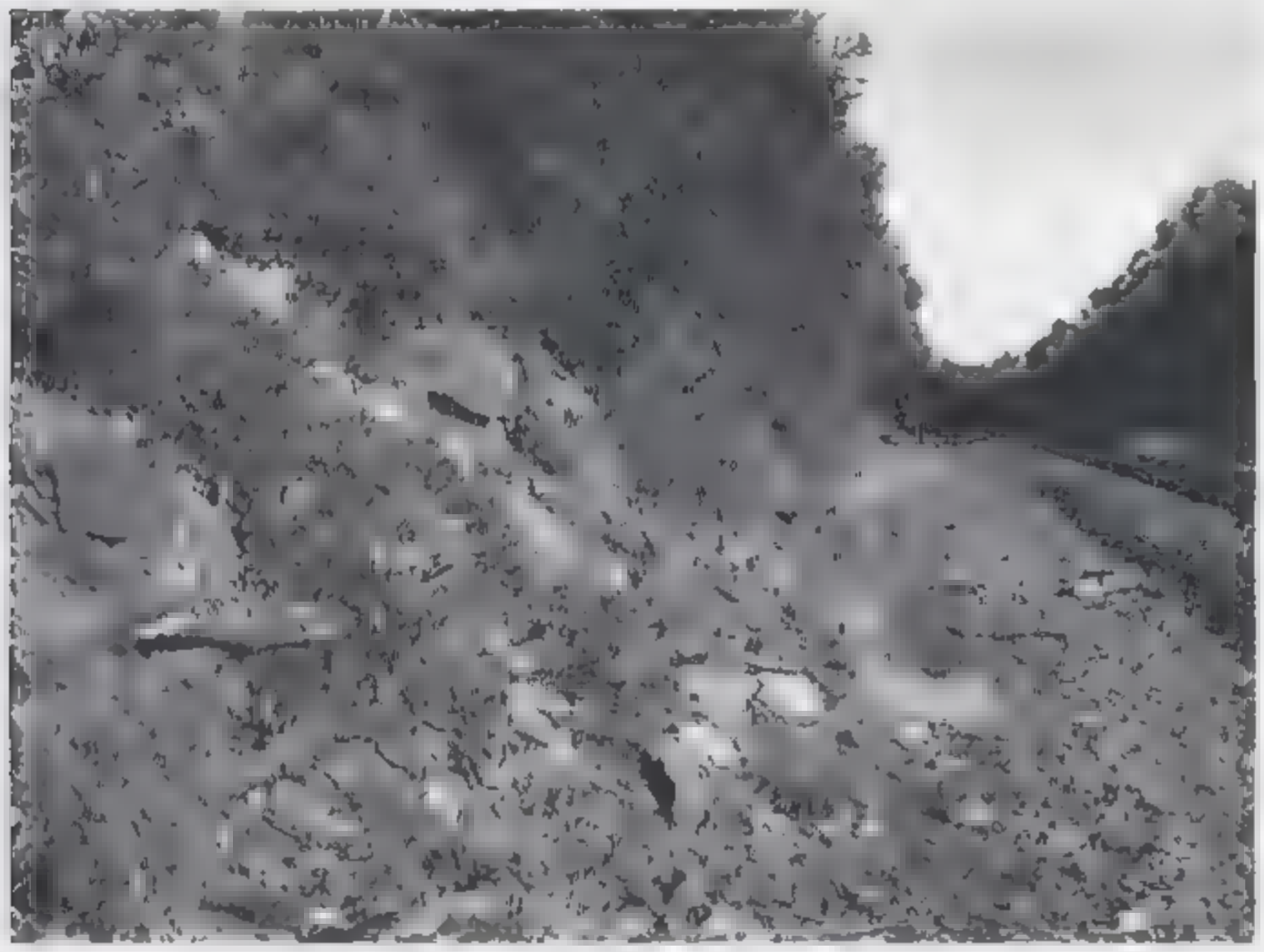
Phoenixville turned out to be one of the most confusing towns I have ever visited in Pennsylvania. The directions from *Gem Trails* seemed straightforward, but the map in the book is not drawn to scale, and in southeastern Pennsylvania the road names can be a problem. I had a copy of Delorme's *Pennsylvania Gazetteer*, which I found to be quite helpful in finding the site, even though not all the roads were named in the *Gazetteer*.

I reached the site by taking state Route 23 to state Route 29, according to the directions in *Gem Trails*. State Route 23 is known as Nutt Road, and you turn north onto state Route 29, which is Manavon Street. This street continues northeast, and then to stay on state Route 29, you turn left (northwest) onto Starr Street. Take Starr Street to the northwest until it ends at a "T," and then turn right (northeast) onto Bridge Street.

The book described a parking area for the collecting site on the west side of state Route 29 just before you cross the Schuylkill River, but I did not see it the first time and had to cross the river and double back. Bridge Street crosses the river, and then its name changes to Phoenix-Collegeville Road. The town on the east side of the river is Mont Clare, further adding to the potential confusion, as the map in *Gem Trails* shows it as still being Phoenixville.

Fortunately, the parking area is easy to find, as it is between the railroad and the river on the northwest side of Bridge Street. Upon further review, I found that all that I had to do was turn onto Bridge Street from state Route 23, but Bridge Street does not become state Route 29 until you near the river. You can take other routes to get there, and it is very easy to find once you are near the river.

The parking area is great, as it has lots of space and it is also used by people that fish the Schuylkill River. I never like to attract attention, and as a geologist it's easy to blend in with fishermen. Both geologists and fisherman generally carry backpacks, have strange hats, and look somewhat disheveled. I parked my car and headed to the collecting site.



The dolomite crystals are on the large rocks and boulders on the northeast side of the railroad

I had to walk across state Route 29, a very busy road, and climb over a concrete barrier into the woods. Unfortunately, since it was August the briars and vines were extremely thick, and I had on shorts instead of long pants. Fortunately, I did not encounter any significant numbers of ticks or spiders, and despite the blood on my legs from the thorn and thistle scratches, there were not any mosquitoes.

The collecting area was reported to be on the northeast side of the railroad tracks opposite the Columbia Station. I climbed up a rock pile that included large pieces and slabs of concrete, rebar, and boulders of what appeared to be dolomite. I soon emerged from the woods and found myself next to the railroad tracks. The rock pile extended a few hundred feet to the southeast.

I did not see any trains, which is always good when you are near rail tracks. The Columbia Station turned out to not be a rail station, but a banquet facility, and was hosting a wedding reception. I definitely did not look like I was part of the wedding party, and fortunately I was far enough away to be neither a disturbance nor viewed as a potential threat. The cooks and waiters came out back to smoke, but they did not pay any attention to me. They probably had seen many other people looking for crystals on these rocks.

Almost immediately, I found what I was looking for. The sides of many of the boulders and rocks had well-formed crystals. These were generally dark orange, and some of the crystals were up to ¼ inch in diameter. The rocks with the crystals were right on the surface, and I only had to use my hammer for trimming specimens.

The area had undoubtedly been visited by many rockhounds before, as I saw many small piles of crystals on some of the boulders. You could easily pick up rocks by hand, but work gloves are needed, as bare fingers are easily pinched and scraped by the large, heavy slabs and pieces of dolomite. I found it useful to turn over large pieces and look for crystals on sides of pieces that previous collectors had not seen.

The dolomite boulders were certainly not part of the bedrock, as the bedrock in this area is mapped as Triassic Stockton Formation, which is a dark-red to brown arkosic sandstone. The boulders were brought to the site either for fill or to construct a small berm along the rail line. They were heavily overgrown with vegetation, and there were no indications that anyone was planning to move them in the future.

The collecting area stretched for several hundred feet along the rail line. I did not see any "no trespassing" signs or warning signs from the railroad. If I had seen any signs, I would have gone to the other side of the rock pile that faced the Schuylkill River. There were nice pieces on this side, but it was harder to find them, as the vegetation was much thicker and the area was darker, not being exposed to the sun

The bank that faced the river was also quite steep in places, and this made it hard to collect along the river side of the pile. In contrast, the rail line side of the pile was very level and you could easily walk along it and find orange crystals very rapidly.

I had soon collected some very nice pieces and filled my backpack. I left many more behind for future collectors. I did not want to walk back the way that I came, as the briars were very bad, so I attempted to walk out along the river under Bridge Street and then hike up to the parking area.

The river itself was full of rocks that appeared to be dolomites, limestone and gneisses. They were covered with a fine mud deposited by the river, so it was hard to tell what they were without a lot of hammering. The bridge piers were surrounded by large pieces of carbonate, but I did not find any crystals on these rocks. At first, I though the orange crystals were limited to the area by the rail tracks. However, I found a boulder of dolomite with a small section of orange crystals on my way up to the parking area. This suggested that there might be some other sections of rocks with orange crystals, as well.

I did not have any acid with me in the field, but I checked some of the crystals later with dilute hydrochloric acid. They hardly fizzed at all, but they seem to lose some of their orange color when treated with acid. They were also quite hard and difficult to scratch, which indicated they were definitely harder than calcite. Nearly all of the crystals were small rhombohedrons, but some of the larger crystals had rounded edges that gave them a curved shape. The host rock, when scratched, would fizz slightly when in contact with the acid, which suggested to me that this was indeed a dolomite host rock.

Although none of my tests were 100 percent diagnostic, they seemed to indicate that the crystals were dolomite, or maybe ankerite. The fact that some of the orange color would wash out with acid seemed to indicate that the crystals were not necessarily ankerite, but iron-stained dolomite. However, the very deep orange color of many of the crystals indicated that they might also be ankerite, or at least contain some component of iron. Regardless, the pieces with the larger crystals made very interesting display pieces.

If I wanted to get really rigorous with the identification, I would likely have to use some other means to determine the actual composition, such as chemical analysis or an electron microprobe, but this is not part of my current collecting budget. This would make an interesting study for a geology or material science student with access to an electron microprobe who is looking for a class project.

The GPS coordinates for the site are 40° 08.056N, 75° 30.592W, and the coordinates for the parking area are 40° 08.123N, 75° 30.581W. This is in degree, decimal minutes format. The collecting area is near the southeast corner of the Phoenixville, PA 7.5-minute topographic quadrangle, but you do not need the topographic map to find this site. A street map of Phoenixville is recommended, though, because the streets in the area are so confusing.

A topographic map will, however, tell you about some other potentially interesting sites in the area. About a mile to the northwest is the Black Rock Tunnel, and Black Rock Dam is about one mile north on the Schuylkill River. Any time an area is named for the rocks, especially a colored rock, it has the potential to host some interesting minerals. The bedrock in these areas is mapped as Lockatong Formation, which is dark black argillite with sections of black shale. Although it is not a crystalline or metamorphic rock, it may still be worth checking out, especially if the excavated rocks have any calcite crystals or fossils. It is also possible that additional dolomite boulders may have been brought into these areas.

As long as you remember that the Phoenixville dolomite crystal site is on the southwest bank of Schuylkill and near the rail line, and the parking area is on the northwest side of state Route 29, you should be able to find this site. The site is good for small groups and people with kids, but you must be extremely careful if you have to cross state Route 29, and be especially wary of rock falls if you are on the river side of the rock bank

Given its location near the railroad and the overgrown vegetation, I suspect that the rocks are going to remain here for a while, but there are no guarantees about the future of a site. However, as long as the rocks are not removed, the site will continue to produce good orange crystals for those who take the time to visit.

DID YOU TAKE THIS FIELD TRIP? Send a photo of your finds and a brief description of your experience to **My Field Trip, *Rock & Gem* magazine, 290 Maple Ct., Ste. 232, Ventura, CA 93003.** All submissions become the property of *Rock & Gem.*

BOB FARRAR PHOTO

The agates at Sidi Rahal, and most other Moroccan localities, were formed in vesicles in basalt.

Berber Country Agates

Morocco Has an Incredible Variety

Story by Bob Farrar

PETER AND DENISE WHITEHEAD PHOTO

Solid agates from Sidi Rahal typically have a red rind with blue and white material inside.

Agates are a great favorite of many rockhounds, owing to their endless variety of beautiful colors and patterns, their relative abundance, and their workability as gemstones. I say "relative" abundance because, while agates are certainly more common than many other gemstones, such as topaz or beryl, good material can nevertheless be hard to find, especially in the United States. The same cannot be said of all agate-producing countries, though. I was recently able to visit one country in which beautiful agates are still abundant and easy to find: Morocco.

Morocco has an incredible variety of minerals and fossils, and I have made several trips to see it for myself. All my visits have been arranged by tour leader Sara Mount of Silver Spring, Maryland, and her Moroccan guide, Aissa Aaronson. Our most recent trip was in September 2006. (The spring and the fall are the best times to go to Morocco; the summer can be brutally hot, and in the winter you can hit snow in the mountains.) On this trip, we were joined by long-time agate collectors Peter and Denise Whitehead of Australia. Because of their special interest in agates, Sara made an extra effort to arrange for us to visit three productive agate localities.

It is often not possible to do much actual collecting during a relatively brief visit to a mineral locality in Morocco. Some localities are active underground mines, some are dangerous abandoned mines, some would take too long to excavate, and some are claimed by people who would not want to take a chance that an outsider might find the piece that would have earned them a month's wages. However, at these three

BOB FARRAR PHOTO

Agate nodules of several pounds can be found near Sidi Ayad.

agate localities we were free to "fossick," as Peter and Denise would say, and to pick up whatever we wanted. And so we did.

Morocco's agate localities lie in and around the Middle Atlas and High Atlas mountains. Morocco is a country of highly varied topography, with several mountain ranges. In the northernmost part of the country are the Rif Mountains. In the central part of the country, running northeast to southwest, are the Middle Atlas. Southeast and roughly parallel to the Middle Atlas are the High Atlas. Farther southeast lie the Anti Atlas Mountains. (The "Middle" Atlas are not between the "High" and "Anti" Atlas; they are called the "Middle" because they are intermediate in elevation between the other two.)

The Atlas Mountains are the home of the Berbers, the native people of Morocco. While they adopted Islam after it was brought to Morocco by the Arabs, the Berbers have maintained their own language (several dialects) and culture. Though many are farmers or shepherds, much of the mineral and fossil mining in Morocco is done by Berbers. They are friendly people and hospitable to foreigners, including Americans.

In the Middle and High Atlas mountains, there are a number of basalt formations of Jurassic age. The agates are found in these formations. They have typically formed by filling vesicles, cracks or seams. It has been theorized that the silica for the formation of agate in a basalt originated in the weathering of overlying silica-rich volcanic rocks. Silica then percolated into the basalt and was deposited in cavities as silica gel. Chemical changes then caused the silica to precipitate, first as agate, and later as quartz crystals (R.K. Pabian and A. Zarins, "Banded Agates: Origins and Inclusions," University of Nebraska Educational Circular No. 12, 1994). In some Moroccan localities, many of the vesicles are completely filled with solid agate, while in other cases filling has been incomplete, leaving geodes. Solid agates and geodes can be found side by side in some localities. Many have weathered out of the host rock, while others are found in situ. These formations are typical of many agate-bearing formations around the world, such as those in Rio Grande do Sul, Brazil, or Idar-Oberstein, Germany.

The first locality we visited was near the town of Kerrouchen, which is in the Middle Atlas, about 30 miles west of the city of Midelt. Midelt, located near the lead mines of Mibladene, is the mineral capital of Morocco. Minerals from all over Morocco can be had there. Midelt was our base of operations for several days of exploration. The agate locality is in a beautiful location in a valley right at the edge of the cedar forest that covers much of the Middle Atlas. There is a permanent stream there, which enables gardens and orchards to grow. It is a bit difficult to believe that this place is in the same country as the arid deserts most people envision when they think of Morocco.

The Kerrouchen locality lies at the juncture of two distinct geological formations. On one side of the valley is a copper-bearing sedimentary formation in which azurite and malachite are found. Just across the stream is a basalt formation that hosts the agate. The agates have formed in vesicles as well as in seams, so they are found as both nodules and flat plates. They occur in a variety of colors, including grays, blues and reds. Also present is yellowish-brown material that is more like jasper than typical agate. Most of what we picked up had weathered out of the basalt, though a few thin seams could be seen in situ. It was easy collecting; I quickly filled up a sack with 10 pounds or so. Peter and Denise also got a sackful. We could have stayed longer, but it was getting late in the day and we needed to make it back to the main road before we lost daylight.

continued on page 90

BOB FARRAR PHOTO

A small percentage of the geodes from Sidi Rahal contain amethyst.

Berber County Agates *from page 89*

The next day, we headed out to the second locality near a place called Sidi Ayad, north of Midelt. Sidi Ayad is not a town; it is a location named for a Moslem holy man whose tomb is located there, to which his followers make pilgrimages. Also in the area are abandoned copper prospects that are known for malachite, azurite, fluorite, and other minerals.

Before heading out of Midelt, we met up with two local Berber miners, Hmad and Lahro, with whom Sara has developed a close working relationship over the years. On the way out, we passed Mibladene, site of lead mines famous for their vanadinite, and Aouli, a former lead mining center that is now a ghost town. From Aouli, we headed out across the desert, following nearly invisible tracks in two 4x4 vehicles. Without the two Berbers, we would never have been able to find our way to the agate locality. As the crow flies, we were not all that far from Kerrouchen, but the countryside looked entirely different. There was no lush cedar forest here; only sparse desert shrubs and herbaceous plants. It was still a beautiful place, though; in the hills, colorful geological formations were visible.

This agate locality was at the foot of some hills. There was a dry wash, and the agates were among the gravel and boulders. These agates occurred primarily as nodules. Most did not have a great deal of color to them; they were usually gray, sometimes with a little pink or red, but they typically had nice banding. Many of the nodules had coarsely crystallized quartz inside.

As these would not make good cutting material or polished specimens, I tried to find ones that were chipped or I chipped them with the hammer I had brought to make sure they were good inside. I did not want to haul something heavy all the way back from Morocco without reasonable assurance that it was good. Many of the nodules were large, up to perhaps 10 pounds, so even being selective I soon had another sackful. Peter had brought along some big chicken feed sacks for collecting and soon had all he could carry. While we were having fun in the dry wash, the Berbers had climbed a hill to the source of the agates and brought down another sackful for us to pick from. We left with the cars loaded down.

After getting our fill at Sidi Ayad, we took a break from agates for a while. We spent the next several days in and around Erfoud, at the edge of the Sahara Desert, looking for fossils (see "Fossil Collecting in Erfoud," November 2004 *Rock & Gem*).

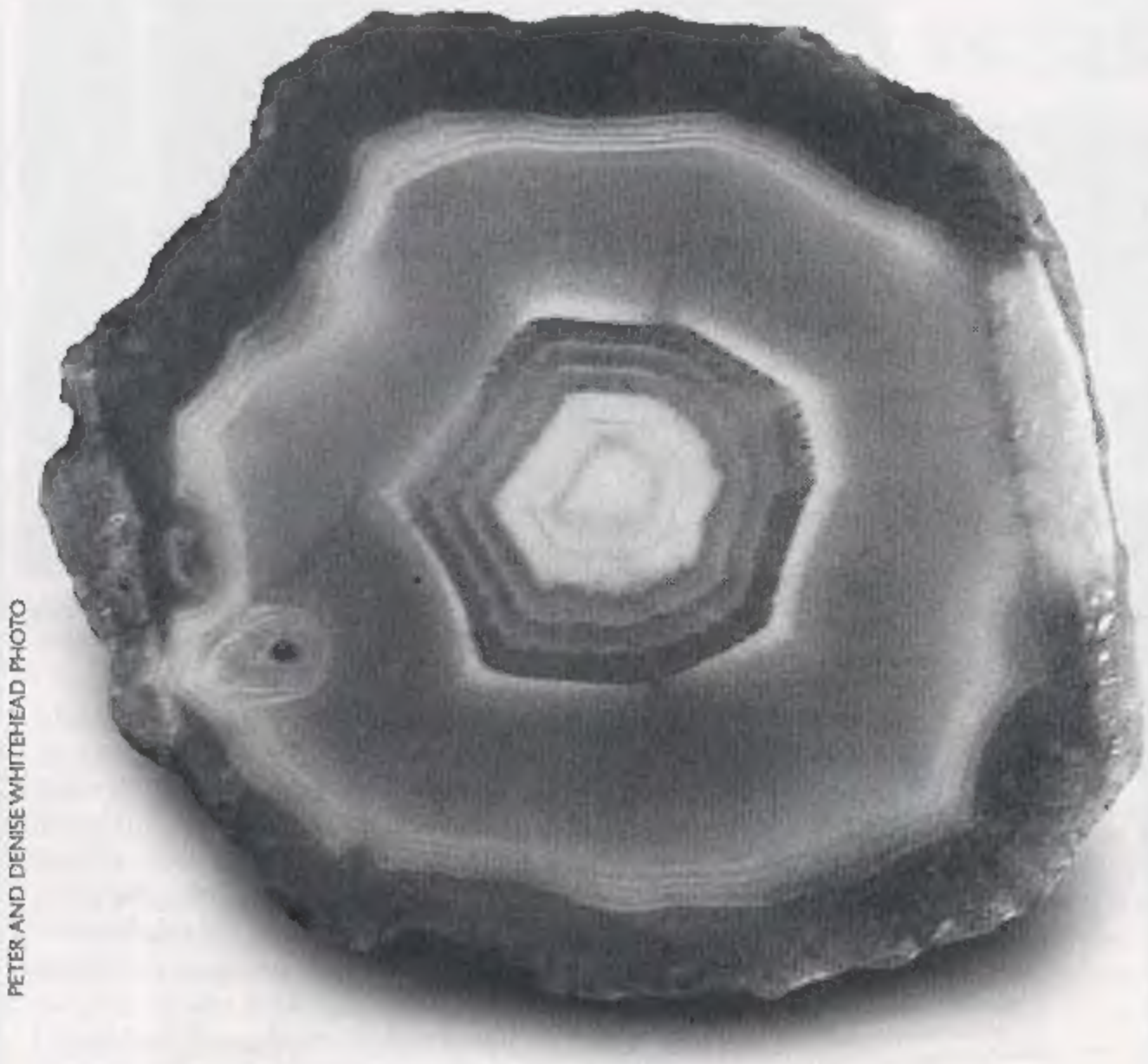
Our third and last chance to hunt for agates came after we crossed the High Atlas on our way to Rabat and departure. This locality was probably the best of all. Located near the town of Sidi Rahal, northeast of Marrakech, it lies at the western foot of the High Atlas. Agates are found at a number of sites in the area. The one that we visited is owned by a man named Mohammed Afriad. He actively mines agates and geodes on his property. Sara had visited Mohammed's mine on previous trips and knew that he always welcomes her travelers.

PETER AND DENISE WHITEHEAD PHOTO

Set in silver, agate from Morocco makes nice jewelry.

Like at other sites in Morocco, the agates at Sidi Rahal are found in basalt, filling vesicles, but not seams. Many of the nodules are hollow. Most of the geodes contain small quartz crystals or druzy quartz, sometimes in stalactitic formations. A small percentage of the geodes contain amethyst. While perhaps not as spectacular as Brazilian amethyst geodes, the amethyst ones are nevertheless quite pretty.

continued on page 98



PETER AND DENISE WHITEHEAD PHOTO

The agates from Sidi Ayad are mostly gray, with some pink and red, and usually have nice banding.

The geodes, as well as the solid agates, typically have a rind of red agate about ⅛ inch to ⅜ inch thick. Within this rind, the solid pieces are usually filled with blue agate, sometimes with white banding. There may also be inclusions of goethite needles, around which the agate may be layered. Sawn and polished, they can be beautiful. The solid agates at Sidi Rahal are smaller than those at the other localities we visited, from under an inch up to about 4 inches across. The geodes can be up to about a foot in diameter. Of the three agate localities that we visited, Sidi Rahal had the most colorful material.

BOB FARRAR PHOTO

Mohammed (standing) mines his agates and geodes with hand tools and mule power.

The basalt that hosts the agates and geodes at Sidi Rahal is quite friable; it is easily broken up with a hammer or pick. The agates usually come free of it easily. Mohammed's prospect covers, at most, a few acres. He has dug along a front across the face of the hill, to a depth of 15 to 20 feet in spots, backfilling the older parts as he went. All of this work is done with hand tools and mule power. Power equipment would not be economical, and would probably damage the geodes. Mohammed does not own a diamond saw, and does not have the electricity for it even if he did. He opens his geodes with a hammer. This takes a bit of skill; he usually produces beautiful specimens, whereas others might end up with a pile of gravel.

Mohammed's main interest is in geodes; he leaves most of the agates in the field. Therefore, he was willing to let us do some collecting. My first impulse was to pick up everything in sight, but I knew I would be overloaded in no time, so I made myself be selective. There were agates that Mohammed had dug up along with his geodes, agates in situ in the basalt, and agates weathered out on the surface. All were easy pickings. I soon had a sackful, and Peter had filled up another chicken feed sack. It was hard to stop.

Mohammed is a devout Muslim, but he is tolerant of those who are not. In previous years when Sara has brought visitors to Mohammed's claim, he has fixed them lunch, typically a tajine, a delicious stew of meat and vegetables. This visit, however, fell during Ramadan, the Moslem holy month, during which believers fast from sunup to sundown. Though his family was not cooking in the middle of the day, he nevertheless insisted that we come into his house and eat the food we had brought with us, and he even gave us some bread and honey to go with it.

After our visit to Sidi Rahal, we headed on toward Rabat, our last stop in Morocco. There, we arranged to have Aissa ship our agates back to our respective homes. When I go to Morocco, I always come back with a suitcase full of rocks, but all these agates would have put me way overweight at the airport. It was a bit more hassle and expense to have them shipped, but I know they will provide us with many hours of cutting and polishing pleasure.

Some of you may be wondering at this point, "How can I get in on these agates?" Well, getting to the collecting sites without a local guide such as Aissa would be difficult. However, it is not hard to see agates in Morocco. The easiest way is to drive southeast from Marrakech on the road to Ouarzazate, over the High Atlas Mountains via the Tizi-n-Tichka Pass. At 7,415 feet, this is the highest vehicular pass in Morocco.

Crossing the mountains, you will pass numerous sellers of rocks. Some have nice shops, some have little roadside stands, and some just stand by the side of the road with a bag of rocks. The quality of their offerings varies tremendously and many have a lot of junk, such as dyed quartz geodes. However, many of them have nice material, and it often includes agates from the local areas. Usually, they will be rough nodules; the dealers in Morocco do not seem to sell polished pieces like they do in Brazil.

The agates can usually be had for a good price; the hardest part may be getting them home. If nothing else, you will enjoy some of the most spectacular scenery in Morocco, which is one of things that keeps me going back.